EXPERIMENT IN WATER DOWSING

THESIS

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The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U. S. Government.

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THESIS

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Acknowledgment

By continuing in the middle of a program as I have done, time to select a thesis topic was limited. The topic of this research was easy to comprehend, but the lessons learned by the process will be carried for the rest of my life.

This work was the result of the time of many people. I wish to thank everyone involved and especially recognize the time and effort of Mr. Lewis Carl. As the subject of the research, he has given himself freely to any request and provided the data to conduct the research.

I wish to thank my thesis committee, Lt Col Kenneth Bauer, Dr Matt Kabrisky, Dr Steve Rogers, and Maj Andy Howell. Your inputs will have made this a much more respectable product. I'm sure we will face a future of stout criticism for the results. I can only say that we reported what we saw.

My humblest thanks go to my family, Genia, my wife, Toni, and the one on the way. You have followed me on this trying adventure for the past two and one-half years. I've got my master's, now it's your turn, Genia. Go get 'em.

David I. Gaisford

Table of Contents

List of Figures

List of Tables

Abstract

Dowsing is a folklore process used to locate an unknown, such as the best location for a water well, by the use of a hand-held device. The process is commonly know as water witching, divining, dowsing or radiesthesia. The practice continues despite the lack of a proven scientific basis.

This research develops an experiment to test the claims of a dowser. Specific procedures are established and statistical theory is applied to determine if one man can identify which of five water lines has flowing water in it better than a chance operator could achieve. The statistical analysis uses Abraham Wald's sequential analysis procedures for establishing when to accept a hypothesis in a binomial situation. The dowser's performance proved to be better than chance. Further research is recommended.

EXPERIMENT IN WATER DOWSING

Chapter 1

Introduction

Robert McNamara appealed for the help of his Marine audience in a 1966 film. He was seeking new and innovative ways to solve military problems of the day. Louis Matacia, "a professional dowser with an impressive record," answered the call and presented himself to the Marine Corps Landing Force Development Center at Quantico, Virginia. Though he met many skeptical people, they let [illegible] proceed to their mock Vietnamese village where he located an underground tunnel system by dowsing (2:199). He subsequently trained some young Marines and asked to show his talent to higher command. His first trainees were shipped to Vietnam and soon had reported success in locating tunnels. An article appeared in the 13 March 1967 edition of *The Observer*, a weekly publication for US Forces in Vietnam, attesting to the success of the Marines (2:206). With increased reports of success reaching the United States, the Marines started to investigate dowsing further.

Dowsing or divining is the process of using a device to locate a known object in an unknown location. It has taken on many forms and may have been practiced since history has been recorded (15:12). The most familiar forms of dowsing are the use of forked branches to locate water and angled rods used to locate pipes underground. Other forms use pendulums as the device.

The Marines' interest in dowsing ended in 1971 when the Commanding General at the Marine Corps Development and Educational Command decided there was no "scientific basis" for the phenomenon (2:213).

In 1990, Lewis Carl , Figure 1, approached Lt Col Kenneth Bauer to offer his services to the United States. He had been dowsing for water since he witnessed a dowser when he was 12 years old. For the past 25 years he has been earning money as a professional dowser and felt he could find water in a harsh desert environment for the troops deployed to the Persian Gulf. As it turned out, finding water was not a problem for the US Forces and his services were not needed.

Lt Col Bauer's curiosity was piqued, however. If Mr. Carl's claims were true, would it not be to our advantage to understand and learn this skill? Much as the Marines who met Louis Matacia in 1966, Lt Col Bauer's meeting with Lewis Carl created more questions than answers. Of the questions that surfaced, the primary one was "Could this man's claim be true?"

A quick review of the literature showed a mixed reaction of believers and non-believers. Mr. Carl presented possible evidence of his success, and Lt Col Bauer decided that there was enough evidence that the subject could not be brushed away. The possibility of success seemed too great to dismiss.

With this background, this research was recommended to try to substantiate if Mr. Carl's claim is valid. If one can establish that he has a skill that can be learned, today's technology may now be ready to measure and quantify its sources. What stopped the Marine investigation into the subject was the inability to scientifically prove the skill exists. In the twenty years that have passed since that time, technology has advanced to the extent that methods exist that can measure many previously undiscovered aspects of human nature. A dowsing sense, if it exists, could be a new aspect.

Problem Statement

Does Mr. Lewis Carl possess the ability to locate subsurface water better than one could expect a person to find water by chance? In this preliminary study the only interest is in discovering if the man has an ability that can be proven through a scientific process to provide a statistically valid result.

Research Objective

This research will be done to study the ability of one man to locate flowing water by dowsing in a controlled experiment. If the dowser can pass the initial study, additional research into the physics of the process may be warranted.

Scope and Limitations

As stated above, this research will be limited to one individual who claims to possess an ability to locate water for landowners who are preparing to drill for domestic water. Dowsers claim to have many more abilities than just locating water, but none of these reported abilities will be tested here.

Figure 1: Mr. Lewis Carl

Chapter 2

Literature Review

The ability to dowse for water is a controversial subject; as such, there are believers and non-believers. This literature review required the study of both sides of the story and analysis of the literature to determine the underlying assumptions. Technical experience or education does not determine who falls into each category. It seems that authors are either set upon proving or disproving dowsing with predetermined notions. Hence, most work appears subject to a prearranged conclusion.

Very little objective information is available on the subject. Most written materials support dowsing but lack hard data to uphold the conclusions presented. Only one book critical of dowsing was found and it presented arguments that followed scientific methodology. Of other critical items found, most were periodical articles. They supposedly reported on experiments, but lacked sufficient data to support this classification. This lack of critical material appears to stem from a typical rift between believers and non-believers of any such sensitive subject. Believers continue to preach their beliefs. The non-believer dismisses what the believer says and does not see much need to continue arguing. Once dowsing has been disproved, in their viewpoint, nothing more needs to be said.

For the dowsing enthusiast, the critical literature does nothing to "dowse" their beliefs. As one author put it:

> It might be much more comfortable to have an explanation that looks something like what other people accept as 'fact': but we don't have one. None that would stand up to any real scrutiny, anyway...
>
> ...But in a way there's no point. As we've seen we don't really *need* to know how it works, as long as it does actually work. Dowsing is far more a technology than a science; and all we need to know in any technology is how it can be *worked*. *(8:*151)

The literature reviewed was from a selection of pro-dowsing literature, the limited items documenting contrary viewpoints, and interviews with the players in this research. This information will be presented in a historical format, following the development of dowsing from both points of view. Additionally, interviews with the dowser of this study and his clients and employers will close the discourse. From these reviews and interviews one can draw definite conclusions about what dowsing is, how dowsers say it works, and how to test the skill.

Quick History of Dowsing

Numerous texts have been written on the subject of dowsing and provide a well-documented history of the subject (Appendix A). The practice of dowsing may be as old as 7000 years (15:12). Barrett and Besterman provide a good introduction into the history (1:1-20). Most other books on the subject reference Barrett and Besterman or provide similar accountings for dowsing's history. Vogt and Hyman summarize Barrett and Besterman's work earlier work (15:12, 15, 16, 23). Dowsing as is commonly practiced today is linked to German miners (1:19) Little has changed in dowsing since these early descriptions.

The Dowsing Argument

Research into the subject of dowsing starts around the turn of the 20th century. At that time, many books had been written on the subject. But without scientific validation of the process, it remained a folklore method. Barrett and Besterman attempted one of the most precise accountings of the success of dowsing. They authored several volumes from work conducted from the late 1890's through the 1920's which culminated in their book *The Divining Rod*, printed in 1979[1]. They trace the history of dowsing, in the form discussed here, to sixteenth century Europe (1:7).

[1]Barrett and Besterman's book published in 1979 was the final work completed by Besterman long after Barrett's death. The entire text is based on work completed during the period mentioned. Barrett and

Many books were written supporting dowsing in the intervening years. Then in 1959, Vogt and Hyman published *Water Witching U.S.A.*, the most thorough scientific study of the subject written to date. They were interested in discovering why the process remained "as vigorous as ever" (15:22). They surveyed 500 County Agricultural Extension agents throughout the United States about dowsing in their counties (15:7). Vogt and Hyman explain that the "strongest argument for water witching comes from case histories" (15:40) Their conclusion, from a scientific perspective was:

> ...we don't have to resort to prejudice to dismiss water witching as invalid. The evidence for it, when assembled and examined, is not merely insufficient; according to current scientific standards (parenthetical omitted), it is appallingly negative (15:82).

Despite these findings, the practice continues. Vogt and Hyman suggests dowsing continues because of "...the difference of opinion between skeptic and believer is in the interpretation of the facts. Each side draws a different moral from the same story (15:81)." A pro-dowsing author supports this conclusion when Christopher Bird criticizes their findings, calling Vogt and Hyman's conclusion "feeble" and based on a bad assumption, that divining can not be "100 percent [accurate] (2:10)."

In 1977, the U.S. Geological Survey entered the picture through a pamphlet on water dowsing. After explaining dowsing, the authors define groundwater and how hydrologists locate it. Based on the data required by the hydrologist to locate water, including "hydrologic, geologic and geophysical knowledge (14:10)," and that "no single technique suffices to locate favorable water-well sites" they concluded "that the expense of further tests of water dowsing is not justified (14:11)." The argument continued.

In 1979, James Randi discussed a $10,000 reward for any dowser who could prove, in a controlled experiment, he had dowsing abilities (13:16). In the experiment, he had a 10m x 10m area constructed with three flowing pipelines. Four dowsers attempted

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Besterman published other books on the subject in early 20th century. See Appendix A for some of their works.

to locate a vein and none of them succeeded. Randi kept his reward, but did not convince any of the dowsers that they lacked their reported skill (13:20).

In 1984, Randi reported on a subject who claimed to have proved the dowsing sense (12:329). By this time, the reward had increased to $110,000. Under Randi's scrutiny, the dowser's claim was found to be linked to "auditory and visual clues." Randi concluded the man had no dowsing sense and did not reward the prize.

In 1987, Norman Eastwood reported on a "human magnetic sense" in an English medical journal. He reported using a pendulum over portions of his body to locate "north and south pole reactions" as those observed in a magnet. Upon his 'test' he decided that it was "conclusive evidence for the existence of a human magnetic sense and that dowsing reactions are associated with it (6:676-7)." Randi called his conclusions unlikely (11:88).

Today, one continues to see articles appearing in popular magazines and local newspapers reporting on the work of dowsers. No amount of scientific work has stopped those who believe from believing in dowsing—or vice versa. A person who has witnessed a dowser, especially one who has received setbacks in the form of dry wells, from "professional" water people, will not be easily convinced that the dowser did not do something special. Conversely, the non-believer continues believing the dowser to be a charlatan or con man.

The Dowsing Problem

Dowsing, in a traditional sense, is the "practice of using a forked stick, rod, pendulum, or similar device to locate underground water, minerals, or other hidden or lost substances (14:3)." According to Graves, it is "a way of using your body's own reflexes to help you interpret the world around you: to find things, to make sense of things, to develop new ways of looking and seeing (8:11)."

From these definitions, two classes of dowsers can be discerned. Those who dowse purely for water or other buried objects and those who dowse for anything. These two groups will be termed conventional dowsers and metaphysical dowsers.

Conventional dowsers, under this classification, are those that use a diving rod and traverse the ground to locate subsurface matter like water and minerals or buried objects like piping. Their divining rods are branches, wire and sometimes implements, but most commonly a forked twig (15:26,27). They can be two branches taped together to form a V-rod or a natural V-rod from a tree (8:77). Typical branches used for these rods are willow and peach, however; cherry, apple, elm, hickory and others are also used (15:26). Metal rods are L-shaped rods whose dimensions vary according to the dowser's preference.

Metaphysical dowsers are those dowsers who attempt to dowse from remote locations or utilize dowsing as Graves has suggested. They may use a pendulum, any weight suspended from a string, or diving rods. Their beliefs hold dowsing as the answer to everyday questions. For example, Graves suggests using dowsing to determine what you are going to drink. You would ask your pendulum if you wanted to drink coffee, if you wanted sugar and milk in the coffee, and the pendulum would give you the answer. He suggests that the pendulum reflects what the body needs and not what the conscious mind tells you. Your mind says you want coffee because you always drink it in the morning. Graves says the pendulum may tell you that your body does not want the coffee at all (8:104).

Remote dowsing fits into this area because the dowser believes he/she can locate objects from a map or by asking the dowsing rod questions about the issue at the remote area. Bird relates several stories of remote dowsing in his book, *The Divining Hand.*

There will be no attempt here to test any metaphysical claims of the dowser. These claims, even if valid, are much too controversial for empirical experimentation when the subject has not been proven, from a scientific standpoint, to provide better odds than chance at solving a particular problem.

Importance and Usage of Dowsing

Dowsing could be an important field if the stories of success are the results of actual dowsing ability. For example, a local landowner had drilled three successive dry wells at his home site. When the dowser was called in, he located a vein of water and the fourth well, drilled at the dowser's specified location, provided an adequate source of water.[2]

If the dowsers' claims are true, uses of dowsing for the military should be developed. The most easily recognized skill is to locate water in remote locations. This could be for troop support or humanitarian missions. Savings in time and manpower from drilling dry wells would be greatly beneficial.

In the environmental arena, one could map high water flows in an aquifer, tracing possible contaminant pathways. One could prepare a preliminary aquifer survey to identify better ways to implement your remediation plan. Alternately, one may be able to locate and trace a contaminant plume.

Interviews with Dowsers

Two dowsers were interviewed to help to understand the dowser and his skill. Each individual has a distinct history of dowsing success reported in local papers and confirmed by happy clients. They are unique and, though their experiences have little in common, their processes share many features. Neither individual knows the other.

Mr. Lewis Carl

Mr. Lewis Carl is a Fairborn, Ohio resident who has been dowsing since he witnessed a man dowsing when he was 12 years old. He started to apply his skill for

[2]Story related to author by Mr. Lewis Carl during interview.

profit about 25 years ago. He has reported excellent success in locating water for residential property owners and commercial land developers. By his account only one well has failed, but due to the well collapsing and not due to water production.

Mr. Carl believes his skill is God-given and that only certain humans possess it at his capacity. He feels that anyone can dowse with metal rods, but only a certain few can utilize a tree's branch. He does not believe in metaphysical dowsing. Whenever he dowses, he grips the V-rod with palms up and claims that he tries to resist any downward pull. He locates water whenever the rod pulls down to a near vertical position.

Mr. Carl is knowledgeable in the geology of the area but has had no formal training in geology. His knowledge is based on a need to understand what he is doing. As such, he knows areas where water is easily found and areas where it is difficult to find. He classifies water as that which is flowing and that which is not. He considers water that is flowing as locatable and flowing in veins. He feels he locates the best place for a well to be drilled based on volume of water which he differentiates by the pull on his V-rod.

To locate a proposed well site, Mr. Carl usually starts by asking his client where he wants the well to be located. He provides information to the client about locating the well with respect to minimum distance from a structure and extra cost associated with locating the well at extreme distances. He then starts to locate 'veins' in the area the client has recommended. He walks briskly across the land and marks the direction of the veins he locates. He attempts to find a point where two such veins cross. This crossing occurs at different depths. He continues until he has located at least two such proposed well locations. He marks each with a stake and writes a somewhat cryptic code to indicate the two veins' depths found in the process described below. Additionally, he initials each stake.

Next, Mr. Carl estimates the depth of the wells he dowses. He has developed a device for gauging depth and reports considerable success. The device, illustrated in Fig 2, is constructed of copper tubing and is 30 inches square. It has spiked tubing on the bottom to allow the device to be pushed into the ground to be free-standing. It has string strung at various angles from a vertex at one end. There is a bubble level on the top to allow Mr. Carl to level the device before using it.

The device is placed ten feet from and perpendicular to the vein Mr. Carl has supposedly located. He stands next to the device facing the vein and holding his V-rod. He then crouches down so his hands are near the top of the device and releases his grip on the rod. The angle the rod dips to is related to a string on the gauge. This gives Mr. Carl and estimate of the depth to the vein of water. Although original in design, the process follows traditional wisdom for dowsers, sometimes called Bishop's Rule, who seek depth: "distance out equals distance down (8:49)."

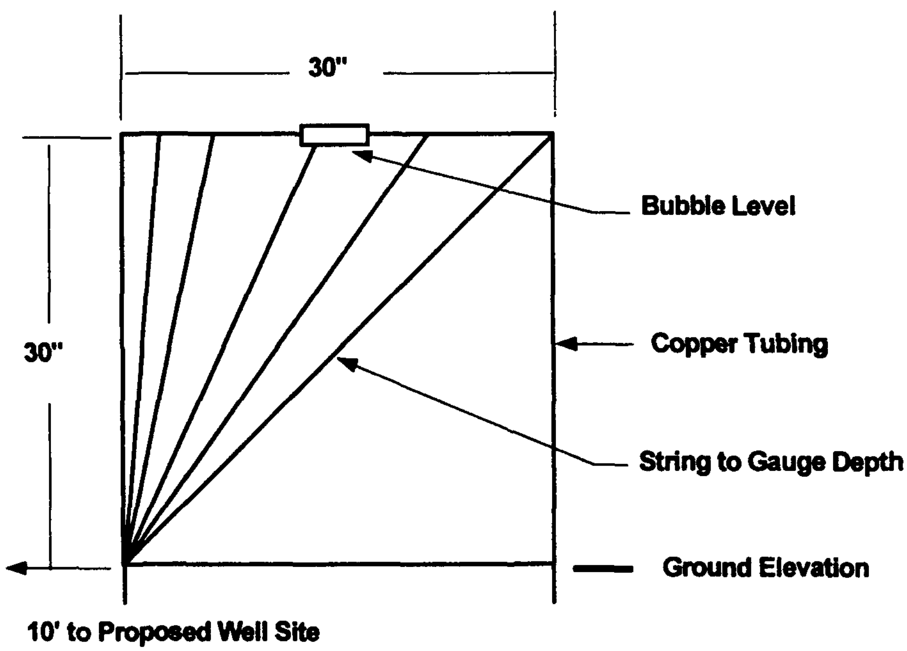

Figure 2: Lewis Carl's Depth Gauge

Mr. Jesse Aites

Mr. Jesse Aites is an Oil City, Pennsylvania resident who has been dowsing for over 40 years in the western Pennsylvania area (Appendix B). He too, believes his skill is God-given. Mr. Aites has enjoyed similar fame and was featured in a 13-minute television newscast in 1961 by KDKA Television in Pittsburgh, Pennsylvania.

Mr. Aites adds one twist to the dowsing equation. He was blinded in 1970. His skill has continued. He dowses with several materials and says he can use as little as one inch of a twig held between his hands to sense water veins. According to him, as he approaches a vein, his toes start to tingle, like when they have fallen asleep. This sensation continues until he is directly over the vein when he becomes nearly "paralyzed" until he releases the diving rod.

Mr. Aites has also dowsed for oil in the western Pennsylvania hills. He has currently stopped this type of dowsing because of his religious beliefs.

How Dowsing Works

The biggest question that needs to be answered is how does the dowsing rod work. Graves believes that the reactions of the rod are due to involuntary muscular reactions to the questions posed by you to the stick or pendulum (8:11). He provides detailed lessons on how to hold pendulums, V-rods and L-rods. He suggests that each is controlled by these muscle movements. To hold a V-rod, he explains that you grab the stick with the palms facing each other, then you twist your forearms so that the vee points outward and your palms are either up or down. "Twist your wrists outward slightly; the rod tip should move upwards sharply..." (8:79) As your body receives the 'answer' or locates the object, muscles will react and allow the stick to move (1:13).

A study by Irons on the behavior of force pendulums linked the motion of a dowser's pendulum to the actions of the fingertips as they tightened, to increase the frequency of the pendulum, or loosened, to decrease the frequency, thus lengthening or shortening the string. (9:113-114)

These processes contradict what the two dowsers who were interviewed said they did to dowse. Mr. Carl said he holds the stick in his hands with the palms up and resists the turning of the rod. Using this technique and the device he developed, he can determine depth of the water source he has located. Even more striking, Mr. Aites says he only requires about one inch of a twig of a tree held between his hands. As he approaches a water vein, he feels a sensation in his toes. As he crosses over the source, he becomes immobilized until he releases the twig.

One of the items both dowsers agree on is that the water must be flowing. Mr. Carl said he could walk up to a swimming pool and get no reaction. This is an important point since most literature that contradicts dowsing or literature that describes dowsing experiments, fails to mention if the water is flowing. One proposed experiment would have you put water in jars. Randi's experiment did mention that water was flowing (13:17)

Geology, Groundwater and Dowsing

There are several points of contention between the supporters and deriders of dowsing. A particular point deals with the aspect of how water is described by dowsers versus what is technically described by geologists and hydrologists. The dowser typically refers to water as running in streams or veins (15:31). Their skill is in finding where these veins are located and typically look for areas where veins cross or run parallel.[3] Technical skeptics refute the dowser's claim by showing that water lies under ground in most of the world, so it would be difficult not to find water when dowsing. One geologist said "the dowser [did not possess] any supernatural faculty [and he ascribed the dowser's] success to a marvelously developed instinct and eye for the country (1:61)."

[3]From description by Mr. Carl during initial interview

Technical models of groundwater do not consider the idea of 'veins' (15:31). Physical laws describe groundwater flow (7:2) and these laws consider groundwater flow to exist like a field, similar to heat transfer and electric fields (7:11). Lithology, the "physical makeup, including the mineral composition, grain size, and grain packing of the sediments or rocks that make up the geological system (7:145)," determines how the water percolates into the ground. As the percolating water enters the saturated zone it becomes groundwater (7:2). Groundwater lies in aquifers as determined by the lithology. The hydrologic cycle recharges aquifers (7:3), and water flows in these aquifers from areas of higher pressure to areas of lower pressure (7:18).

A flow net describes the pressure in the aquifer. For visualization, the hydrologist defines lines of equipotential pressure to show water flow (7:51). Darcy's Law, an empirical definition, relates water velocity to the change in pressure with a proportionality constant, K, defined as the porosity of the soil (7:17). Soils which are highly porous have high K-values and water flows faster in this soil than in a less porous soil. Gravels and sands have high porosity while clays and rock have low porosity (7:16).

The velocity determined by Darcy's Law, or Darcy's velocity, is not the true velocity of the water in the aquifer. This concept represents a macroscopic viewpoint to simplify the process of groundwater modeling and analysis. Water actually flows around each of the various soil particles as it moves in the direction of the aquifer. This becomes the microscopic viewpoint. (7:17) In studying groundwater, the microscopic viewpoint is dismissed because it is too difficult to measure and model and is, in essence, not a necessary study.

Herein lies a potential link between the two sides of this issue. The microscopic view shows that water flows faster in some areas and slower in other areas as the water moves around the soil particles. The hydrologist sees this variation in velocity occurring at the grain size level. A dowser says he feels a vein or stream of water. His classification is macroscopic to him. These two events may in fact be identical. Perhaps reality incorporates both the macroscopic and microscopic viewpoints. The dowser may be locating a region of localized high velocity water that cannot be accounted for by the empirical formulas used in the hydrologist's macroscopic world.

A possible example of this phenomenon was shown during the March 1994 RREL Conference in Cincinnati. A paper was presented that discussed the use of micro-organisms to plug a water pathway that was created during oil recovery. The oil recovery process required water to be pumped into the ground to flush the oil out. During usage, water typically found an alternative pathway, one of lesser resistance. The micro-organisms were fed into the water and the new pathway and then allowed to grow. When they grew, they successfully plugged the alternative pathway. (4:95)

This process shows that water will take the route of least resistance in the ground. As such, in certain pathways, the water will be flowing faster than in others. As erosion of the soil particles progresses, a 'vein' could develop.

Even if this highly speculative idea was true, does the dowser provide the best location for drilling the well? Consideration of this answer is beyond the scope of this research and needs only be addressed if a verifiable dowsing response exists.

Chapter 3

Methodology

> Almost every major scientific boner—and there have been many of them—can be traced to a zealous desire to see the world as we would like it to be rather than as it actually is (15:84).

With this quotation and keeping in mind its wisdom, the chapter that defines the methodology and introduces the dowsing experiment is presented. There will be a discussion of some proposed experiments and the problems presented by them. This provides a foundation for developing our experiment. Next, an experimental methodology is proposed. This will detail the steps to be followed to conduct the work in the field. Finally, the statistical aspects of the proposed experiment are discussed. This includes a recommendation for defining the range of results that lie in the realm of chance and those that are beyond chance.

Proposed Experiments

Numerous dowsing experiments have been proposed by the technical community. The best experiment would be to have the dowser go to a fully characterized site, specify the location and depth of the well, and then drill at that location to verify his work. The full characterization would include complete geological and hydrological analysis of the site before letting the dowser visit the area. The experiment itself is difficult to set up and costly to operate.

Randi's proposed experiment to construct a water circuit under a dirt platform also requires a large budget (13:17). He constructed a 33 foot x 33 foot mounded area with three water routes buried underneath it, 20" below the top of the mound.

Carey suggested placing ten ceramic jars, one filled with water, before the dowser for dowsing. The dowser would then attempt to pick the correct jar. Carey suggests that two trials would be adequate to determine a successful dowser (3:74). According to Mr. Carl, the dowser in this study, this method would invalidate his abilities since he says water has to be moving for him to detect it.

Carey does provide discussion of the aspects of a 'good' experiment. He suggests the experiment should meet two conditions. First, it should be something that "the dowser clearly ought to be able to perform (3:74)." Second, the experiment must eliminate other methods that may be used by the dowser to locate the water. He mentions "cheating, coincidence, inadvertent cueing on our part, visual or audio clues" as some of those methods (3:74).

Martin reported on an experiment that forms the foundation of this work (10:138-139). His experiment used four plastic hoses covered by a rug in a room of a building. One hose was randomly selected to carry water and the dowser attempted to locate that hose. Dowsers could quickly dismiss this experiment because of the site. The structure would have several 'influences' that would interfere with claimed dowsing skills.

Methodology for the Dowsing Experiment

This experiment will be conducted to meet all essential criteria presented by both sides of the dowsing argument. To meet the rules of scientific study, the experiment will follow a systematic approach that can be repeated. To meet the concerns of dowsers, the experiment will be set up to address, as much as is practical, all possible influences, accounting for any outside influences that may occur.

As mentioned earlier, the experiment proposed by Martin (10:138-139) provides the foundation for this experiment. A flow network as shown in Figure 3 will be constructed with plastic piping. See Figure 4 for the control manifold used for selecting a

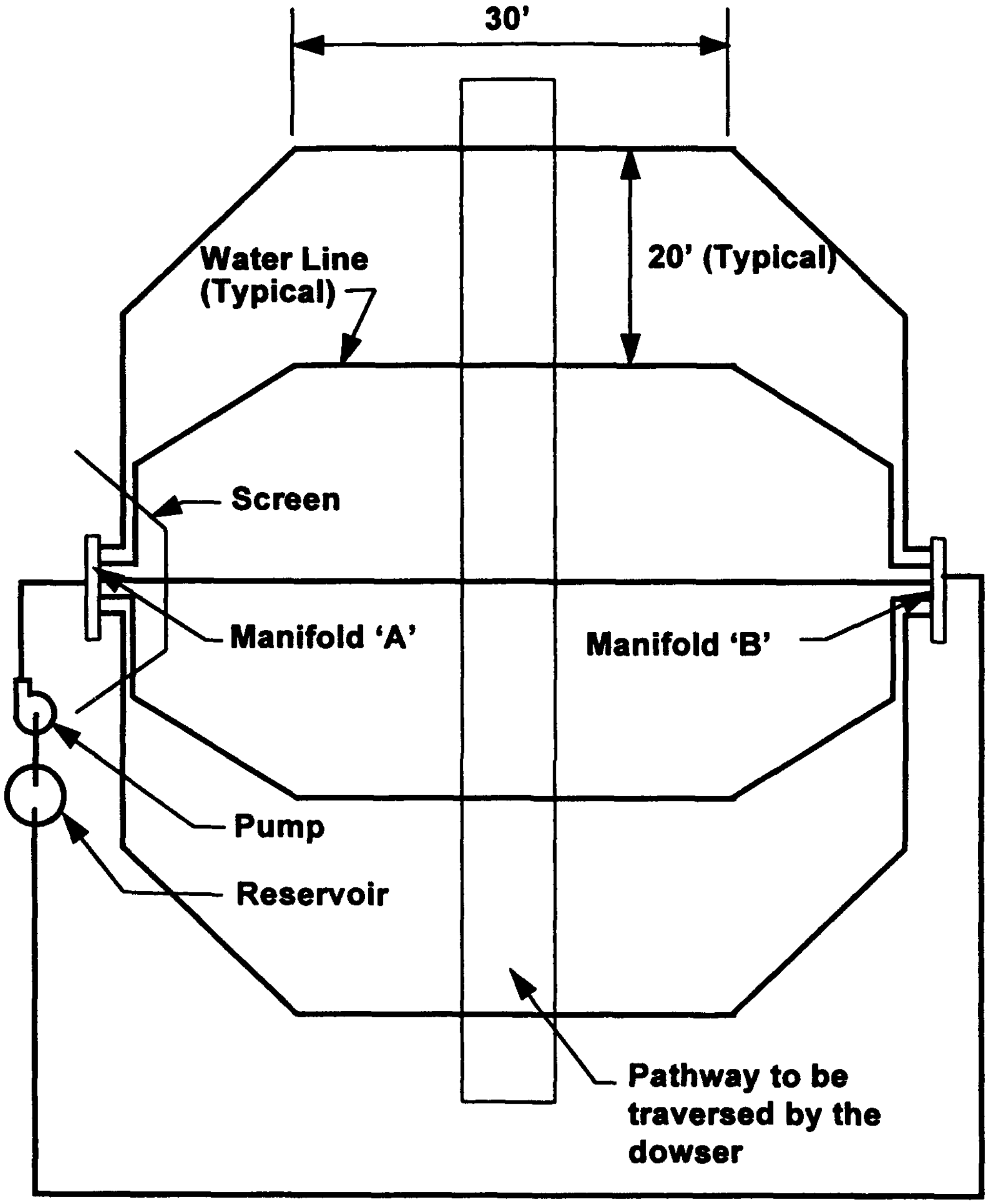

Figure 3: Schematic of Proposed Network

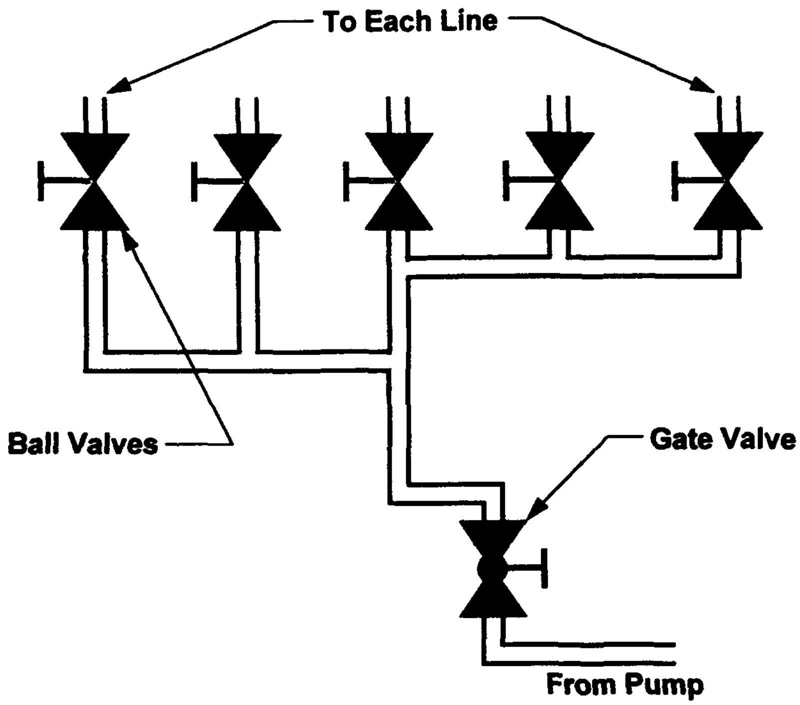

Figure 4: Manifold 'A'

water route. A pump will be used to keep the water flowing. The network will be constructed with sufficient distance between lines to insure there can be no claim of line to line interference. Backflow preventers will be used at Manifold 'B' to keep water from flowing into an evacuated line. The control manifold area will be screened from the dowser. The site that the network will be placed on will be selected prior to construction. The dowser will be asked to locate single path that he feels has no groundwater or manmade interferences. This pathway will be marked with stakes before constructing the experiment. If the area is remote, a generator will be used to run the pump. Finally, the network will be set up after the site has been selected and the dowser will be tested as soon as possible after construction. Specific test procedures are outlined in Fig 5.

Dowsing Experiment Procedures

1. Select area prior to constructing system by having dowser reconnoiter area for a location that dowser believes to have no groundwater influences.
2. Set up network, controls and screen. Check system for leaks. Insure proper operation and insure screen properly shields valves.
3. Insure Manifold 'A' operator knows proper method for determining random order of valve operation, proper recording procedures and importance of not providing visual clues.
4. Test dowse with stagnant water in lines to confirm site remains non-influential.
5. Set controls to run water in one line. Allow dowser to cross network, knowing which line is flowing. Validate process is working and dowser has no complaints. Resolve any issues.
6. Initiate trials. Record data for which pipe water is running through and which pipe dowser selects. Plot results on graph to determine number of trials to execute. Do not inform dowser of individual results.
7. Continue through trials until the null hypothesis can be accepted or rejected based on graph mentioned above.

Figure 5: Experiment Test Procedures

Establishing Statistical Validity

The purpose of this experiment is to determine whether or not the dowser is guessing when he selects a pipe in the network. To make this judgment, one can compare the dowser's performance against the performance of someone who is known to be guessing. The known guesser would be expected to perform no better than chance. If the dowser's performance is no better than chance, it would be reasonable to assume he was guessing. If his performance was markedly better than chance, it would be reasonable to assume he was not guessing. If the dowser's performance was somewhere in between the two extremes, the performance would be difficult to classify. Therefore, comparing the performance against a probability of success provides useful data, but it is not suited to making such a judgment. An alternative method is required to speak with confidence about the dowser's claimed skill.

Hypothesis testing provides this alternative. In hypothesis testing, two opposing hypotheses are proposed and relevant data is collected that will support accepting one of the hypotheses as the true hypothesis. Associated with each hypothesis will be a measure of error, called Type I or Type II error. This combination of hypothesis and error provides a better way of classifying the dowser's performance.

The following sections describe a binomial probability distribution and present an equation for determining the cumulative odds for successive trials. After establishing this, there is a discussion of hypothesis testing followed by a discussion of the hypotheses to be tested. Finally, a method for determining when to accept or reject the hypotheses is suggested.

Binomial Probability Distribution

The design of the experiment suggests a binomial probability distribution, that is, only two outcomes for each trial are possible. The outcomes are either the dowser identifies the proper line or he identifies another line. For these two outcomes, a success will be defined as correctly identifying the water line with water flowing in it and a failure will be defined as identifying some other line or failure to identify any line. For a person who is know to be guessing, the probability of a success in this experiment is 1 in 5 or 0.2 for each trial. Using the binomial formula,

$$P(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x} \tag{1}$$

where,

x = number of favorable outcomes
n = number of events
p = probability of success

one can determine the probability of success for a series of trials. For example, if the dowser was to cross the network ten times, then the probability of 10 successes is:

$$P(10) = \frac{10!}{10!(10-10)!} 0.2^{10}(1-0.2)^{(10-10)} = 1.024\text{x}10^{-7} \tag{2}$$

Table 1 presents these probabilities for the first 30 trials. As can be seen, the probability of the dowser correctly identifying the proper line on every trial diminishes quickly.

Although the probabilities diminish rapidly, one cannot establish regions where you are certain that the dowser's abilities have been supported or unsupported. For example, suppose the dowser selects the correct line five times out of 20 trials. He has beaten the odds, but one cannot say with any confidence that the dowser was not guessing. Perhaps his next five trials would not be successful. He would then be back at the experiment's basic odds. Some other means must be used to establish what is "better than chance."

Hypothesis Testing

Hypothesis testing provides a better means to evaluate what is better than chance. According to Devore, hypothesis testing is a method "to decide which of two contradictory claims about [a] parameter is correct (5:283)." It is a process of

Table 1: Probability of Success After n Trials with p = 0.2

Trials	Successes 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0.2														
2	0.32	0.04													
3	0.384	0.096	0.008												
4	0.4096	0.1536	0.0256	0.0016											
5	0.4096	0.2048	0.0512	0.0064	0.00032										
6	0.39322	0.24576	0.08192	0.01536	0.00154	6.4E-05									
7	0.367	0.27525	0.11469	0.02867	0.0043	0.00036	1.3E-05								
8	0.33554	0.2936	0.1468	0.04588	0.00918	0.00115	8.2E-05	2.6E-06							
9	0.30199	0.30199	0.17616	0.06606	0.01652	0.00275	0.00029	1.8E-05	5.1E-07						
10	0.26844	0.30199	0.20133	0.08808	0.02642	0.00551	0.00079	7.4E-05	4.1E-06	1E-07					
11	0.23622	0.29528	0.22146	0.11073	0.03876	0.00969	0.00173	0.00022	1.8E-05	9E-07	2E-08				
12	0.20616	0.28347	0.23622	0.13288	0.05315	0.0155	0.00332	0.00052	5.8E-05	4.3E-06	2E-07	4.1E-09			
13	0.17867	0.26801	0.24567	0.15355	0.0691	0.02303	0.00576	0.00108	0.00015	1.5E-05	1E-06	4.3E-08	8.2E-10		
14	0.15393	0.25014	0.25014	0.17197	0.08599	0.03224	0.00921	0.00202	0.00034	4.2E-05	3.8E-06	2.4E-07	9.2E-09	1.6E-10	
15	0.13194	0.2309	0.25014	0.1876	0.10318	0.04299	0.01382	0.00345	0.00067	0.0001	1.1E-05	9.5E-07	5.5E-08	2E-09	3.3E-11
16	0.11259	0.21111	0.24629	0.20011	0.12007	0.05503	0.01965	0.00553	0.00123	0.00021	2.9E-05	3.1E-06	2.3E-07	1.3E-08	4.2E-10
17	0.0957	0.1914	0.23925	0.20935	0.13608	0.06804	0.02673	0.00835	0.00209	0.00042	6.6E-05	8.3E-06	8E-07	5.7E-08	2.9E-09
18	0.08106	0.17226	0.22968	0.21533	0.15073	0.08165	0.03499	0.01203	0.00334	0.00075	0.00014	2E-05	2.3E-06	2.1E-07	1.4E-08
19	0.06845	0.15402	0.2182	0.2182	0.16365	0.09546	0.04432	0.01662	0.00508	0.00127	0.00026	4.3E-05	5.8E-06	6.2E-07	5.2E-08
20	0.05765	0.13691	0.20536	0.2182	0.17456	0.1091	0.05455	0.02216	0.00739	0.00203	0.00046	8.7E-05	1.3E-05	1.7E-06	1.7E-07
21	0.04842	0.12106	0.19167	0.21563	0.18329	0.12219	0.06546	0.02864	0.01034	0.0031	0.00078	0.00016	2.8E-05	4E-06	4.7E-07
22	0.04058	0.10653	0.17755	0.21084	0.18976	0.13441	0.07681	0.036	0.014	0.00455	0.00124	0.00028	5.5E-05	8.8E-06	1.2E-06
23	0.03394	0.09334	0.16335	0.20418	0.19397	0.14548	0.08833	0.04416	0.0184	0.00644	0.0019	0.00048	0.0001	1.8E-05	2.7E-06
24	0.02833	0.08146	0.14934	0.19602	0.19602	0.15518	0.09976	0.053	0.02355	0.00883	0.00281	0.00076	0.00018	3.5E-05	5.8E-06
25	0.02361	0.07084	0.13577	0.18668	0.19602	0.16335	0.11084	0.06235	0.02944	0.01178	0.00401	0.00117	0.00029	6.3E-05	1.2E-05
26	0.01965	0.06139	0.12278	0.1765	0.19415	0.16988	0.12134	0.07205	0.03602	0.01531	0.00557	0.00174	0.00047	0.00011	2.2E-05
27	0.01632	0.05304	0.1105	0.16576	0.19062	0.17473	0.13105	0.08191	0.04323	0.01945	0.00752	0.00251	0.00072	0.00018	3.9E-05
28	0.01354	0.0457	0.09901	0.1547	0.18565	0.17791	0.13979	0.09174	0.05096	0.02421	0.0099	0.00351	0.00108	0.00029	6.7E-05
29	0.01122	0.03927	0.08835	0.14357	0.17946	0.17946	0.14741	0.10135	0.05912	0.02956	0.01276	0.00479	0.00156	0.00045	0.00011
30	0.00928	0.03366	0.07853	0.13252	0.17228	0.17946	0.15382	0.11056	0.06756	0.03547	0.01612	0.00638	0.00221	0.00067	0.00018

Table 1: Odds for Successive Binomial Trials

Table 1: Probability of Success After n Trials with p = 0.2 (cont)																
		Successes														
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	1															
	2															
	3															
	4															
	5															
	6															
	7															
	8															
	9															
	10															
	11															
	12															
T	13															
r	14															
i	15															
a	16	6.6E-12														
l	17	8.9E-11	1.3E-12													
s	18	6.4E-10	1.9E-11	2.6E-13												
	19	3.3E-09	1.4E-10	4E-12	5.2E-14											
	20	1.3E-08	7.7E-10	3.2E-11	8.4E-13	1E-14										
	21	4.4E-08	3.2E-09	1.8E-10	7E-12	1.8E-13	2.1E-15									
	22	1.3E-07	1.1E-08	7.9E-10	4.1E-11	1.6E-12	3.7E-14	4.2E-16								
	23	3.4E-07	3.5E-08	2.9E-09	1.9E-10	9.5E-12	3.4E-13	7.7E-15	8.4E-17							
	24	8.1E-07	9.5E-08	9.2E-09	7.3E-10	4.6E-11	2.2E-12	7.4E-14	1.6E-15	1.7E-17						
	25	1.8E-06	2.4E-07	2.6E-08	2.4E-09	1.8E-10	1.1E-11	4.9E-13	1.6E-14	3.4E-16	3.4E-18					
	26	3.7E-06	5.5E-07	6.9E-08	7.2E-09	6.3E-10	4.5E-11	2.6E-12	1.1E-13	3.5E-15	7E-17	6.7E-19				
	27	7.3E-06	1.2E-06	1.6E-07	2E-08	2E-09	1.6E-10	1.1E-11	6E-13	2.5E-14	7.5E-16	1.4E-17	1.3E-19			
	28	1.4E-05	2.4E-06	3.7E-07	4.9E-08	5.5E-09	5.2E-10	4.1E-11	2.7E-12	1.4E-13	5.6E-15	1.6E-16	3E-18	2.7E-20		
	29	2.4E-05	4.7E-06	7.8E-07	1.1E-07	1.4E-08	1.5E-09	1.4E-10	1E-11	6.5E-13	3.3E-14	1.3E-15	3.5E-17	6.2E-19	5.4E-21	
	30	4.2E-05	8.6E-06	1.6E-06	2.5E-07	3.4E-08	4E-09	4.1E-10	3.6E-11	2.6E-12	1.6E-13	7.5E-15	2.8E-16	7.5E-18	1.3E-19	1.1E-21

Table 1: Odds for Successive Binomial Trials (Cont.)

statistical inference (5:283) used to help one make decisions about a population by evaluating a sample from that population. In the case of the dowsing experiment, the parameter is the probability of success. The two contradictory claims are called the null and alternate hypotheses with the null hypothesis stating the accepted point of view.

Whenever testing a hypothesis, there is a possibility of making errors (5:283). These errors are caused by the fact that one takes a sample that is supposed to be representative of the population. There is always a chance that the sample is not representative and making statistical inference from an unrepresentative sample would cause one to accept or reject the wrong hypothesis. These errors are called Type I and Type II. A Type I error is an error caused by rejecting the null hypothesis when it is true. A Type II error is an error caused by accepting the null hypothesis when the alternate hypothesis is true (16:16; 5:286). Associated with each type of error is a probability of making that error. For Type I errors, this probability is named α and for Type II errors, it is named β.

Once the hypotheses are stated, the number of samples to take to determine whether to accept or reject the null hypothesis is decided (16:13). From this point, data is collected to test the hypotheses and when evaluated will provide information necessary to make your judgment.

The problem with this approach in an experiment involving humans is the possibility that you may not complete the required number of samples during the course of the experiment. The subject could quit, or become sick during the experiment forcing cancellation and incomplete data collection.

Abraham Wald proposed using sequential analysis in situations where the number of observations was not determined before the experiment (16:1). Sequential analysis, a statistical inference method, results in fewer samples being taken than would be required by non-sequential methods (16:1-2). The design of the dowsing experiment and the use of a human subject suggest that the analysis of this data utilize Wald's methods.

Wald's Equations

As a special application of sequential analysis, Wald explained how to use his theory in lot selection during a manufacturing process (16:88). The lot is accepted or rejected based on a series of inspections that determine if each randomly chosen item from the lot is defective or non-defective. The inspections are recorded on a chart until the plotted data breaks one of two parallel lines constructed on the chart, or a table that indicates how many rejects you can tolerate. The area bounded by the parallel lines on the chart represents a gray area established prior to beginning the inspections by use of "practical considerations" (16:89) These considerations are discussed below. First, one needs to study the equations and the effects the parameters have on the acceptance and rejection lines.

Wald provides his equations in two formats to assist people manually generating data for his test. His first equations are used to generate acceptance and rejection numbers. The numbers would have been tabulated before the inspection and used to determine when to accept or reject the null hypothesis. They are as follows:

$$a_m = \frac{\log\frac{\beta}{1-\alpha}}{\log\frac{p_1}{p_0} - \log\frac{1-p_1}{1-p_0}} + m\frac{\log\frac{1-p_0}{1-p_1}}{\log\frac{p_1}{p_0} - \log\frac{1-p_1}{1-p_0}} \tag{3}$$

and

$$r_m = \frac{\log\frac{1-\beta}{\alpha}}{\log\frac{p_1}{p_0} - \log\frac{1-p_1}{1-p_0}} + m\frac{\log\frac{1-p_0}{1-p_1}}{\log\frac{p_1}{p_0} - \log\frac{1-p_1}{1-p_0}} \tag{4}$$

where:

a_m = Acceptance Number

r_m = Rejection Number

m = Trial number

p_0 = Lower Bound of Probability

p_1 = Upper Bound of Probability

α = Probability of Type I error

β = Probability of Type II error

Wald's second set of equations defines the slope, the same for both lines, and intercepts of the lines used to generate the graph for data collection. This graph is easier to use than the table since one can see the only three possibilities required to work with his theory—accept the null hypothesis, reject the null hypothesis, or continue testing. The equations for the graph are as follows:

$$h_0 = \frac{\log \frac{\beta}{1-\alpha}}{\log \frac{p_1}{p_0} - \log \frac{1-p_1}{1-p_0}} \tag{5}$$

$$h_1 = \frac{\log \frac{1-\beta}{\alpha}}{\log \frac{p_1}{p_0} - \log \frac{1-p_1}{1-p_0}} \tag{6}$$

$$s = \frac{\log \frac{1-p_0}{1-p_1}}{\log \frac{p_1}{p_0} - \log \frac{1-p_1}{1-p_0}} \tag{7}$$

where:

h_0 = Intercept for Acceptance Line

h_1 = Intercept for Rejection Line

s = Slope of the lines

p_0 = Lower Bound of Probability

p_1 = Upper Bound of Probability

α = Probability of Type I error

β = Probability of Type II error

Analysis of the Parameters

Equations (3) through (7) rely on four parameters p_0, p_1, α, and β. As stated, Wald provides no guidance for determining the values of these parameters. His only discourse on the parameters is a discussion of the effect changing the probability has on your preference for accepting or rejecting a manufactured lot of material. Per his discussion, if the observed probability of a defect occurring is greater than the true probability, your preference is to reject the lot. This preference increases as the observed probability of failure increases. The reverse is also true. As the observed probability of a defect occurring decreases below the true probability, your preference is to accept the lot (16:89).

Two of the parameters, α and β, are associated with the hypotheses as discussed earlier. The other two parameters, p_0 and p_1, are associated with the probability of the event occurring. In the context of the dowsing experiment, this would be the probability of success for a person who is know to be guessing, p'.

Rather than working with a lot of material, this experiment uses all trials that could possibly be accomplished in the experiment as the lot. The null hypothesis can be stated as the dowser's ability is no better than chance. If the experiment tests the dowser's reported ability, then, each attempt to dowse would be considered a sample. Each sample has an associated true probability of occurring related to the probability of the person known to be guessing, p', and an actual probability of occurring related to the dowser's true ability to dowse, p. Therefore, analogous to the previous discussion, if the observed probability of the dowser's ability is greater than the true probability of the person known to be guessing, $p > p'$, your preference is to reject the null hypothesis. This preference increases as the observed probability of the dowser's ability increases. And, as the observed probability of the dowser's ability decreases below the true probability, $p < p'$, your preference is to accept the null hypothesis.

As previously discussed, the probability of correctly identifying the line with flowing water, if the dowser is guessing, is 0.20. This value becomes p'. The values for p_0 and p_1 are established to fit the preferences stated above with $p_0 \leq p'$ and $p_1 > p'$. Thus, define $p_0 \leq 0.20$ and $p_1 \geq 0.20$.

Wald states when the observed probability is close to the true probability you could accept or reject the null hypothesis without significant consequence of error (16:89). The key, then, becomes establishing p_0 and p_1 where you believe there *would* be a consequence in making the wrong decision.

Reviewing the equations and plotting different combinations of the parameters helps to create an understanding of the effect each parameter has on the resultant test. Using a graphing program and equations (3) and (4) one can quickly process several combinations of parameters. Figures 6 and 7 show two combinations of the parameters with α and β held constant.

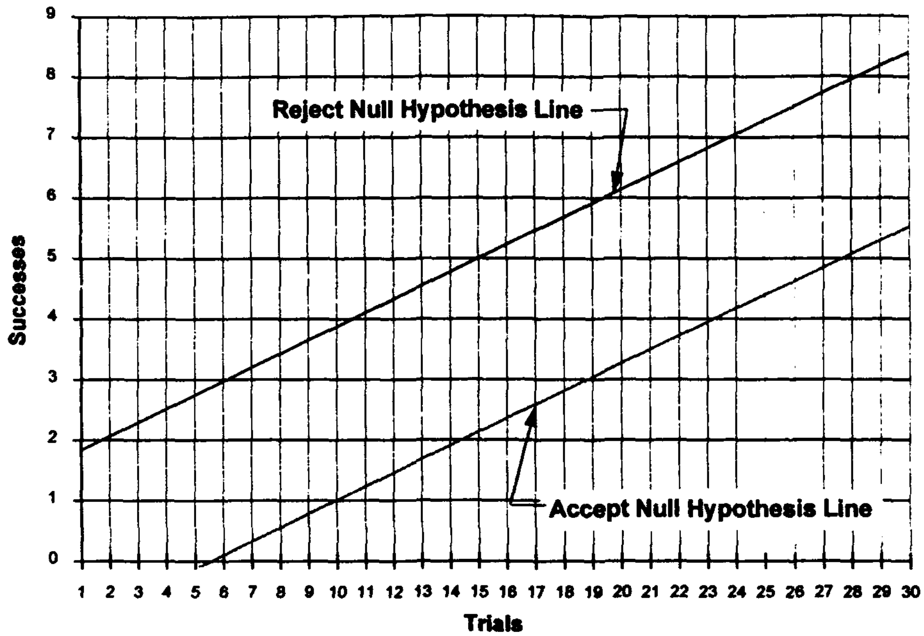

Figure 6: Graphical Test with $\alpha = 0.05$, $\beta = 0.10$, $P_0 = 0.10$, $P_1 = 0.50$

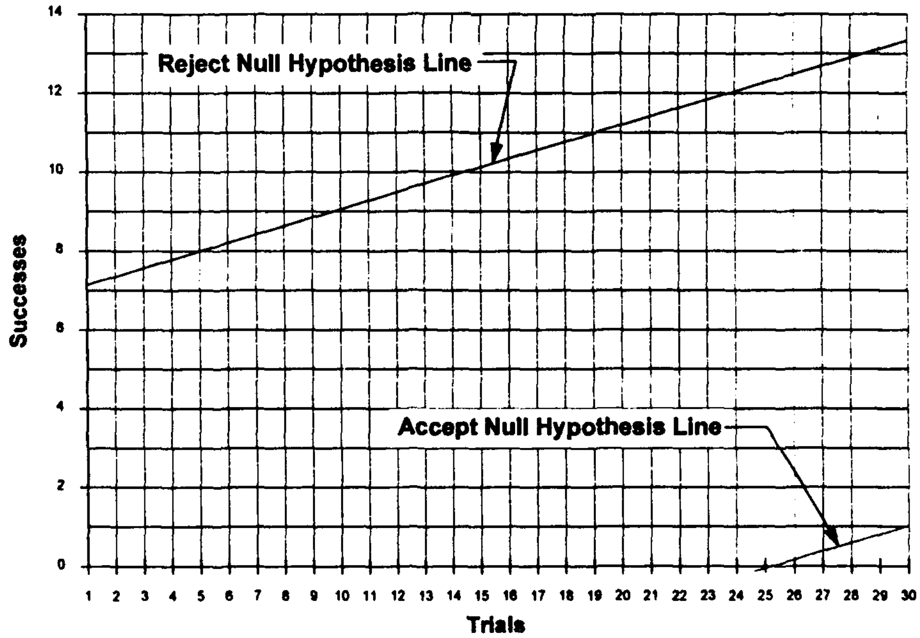

Figure 7: Graphical Test with $\alpha = 0.05$, $\beta = 0.10$, $P_0 = 0.18$, $P_1 = 0.25$

These figures show the effect on testing as the values for P_0 and P_1 change. When P_0 and P_1 are close to the true probability, the gray area is large and a large number of samples would have to be taken to break either line. When P_0 and P_1 are farther away from the true probability, the lines are closer and this lessens the number of samples that must be taken.

Additional analysis of the graphs using other combinations of the parameters and review of the Wald's equations shows the following relations between the parameters. First, α and β control line separation, with α affecting the "reject null hypothesis" line and β affecting the "accept null hypothesis" line. P_0 and P_1 affect both lines as their values change and affect the slope and line separation. See Figure 8 for a explanation of these relationships. With this information the experiment's values for these parameters can be chosen.

Parameter	Change	Slope	Line Separation	Line Affected	Analysis
α	▼	n.c.	▲	Reject H_0	Conduct more testing before rejecting the null hypothesis
β	▼	n.c.	▲	Accept H_0	Conduct more testing before accepting the null hypothesis
P_0	▲	▲	▲	both	Quicker acceptance of H_0, more testing to reject H_0
P_1	▲	▲	▼	both	Quicker acceptance of H_0, less testing to reject H_0

Figure 8: Wald's Equations Parameter Analysis

Determining the Experiment Parameters

Before the parameters are chosen, the hypotheses must be stated. Wald implicitly stated his hypothesis: the manufactured material is acceptable. The inspection of pieces of the lot supports or rejects his hypothesis. In the dowsing experiment, the inspection becomes observation of the dowser and the data to record becomes his success or failure on each trial. As such, the hypotheses will be stated as follows:

H_0 : The dowser's claimed ability is no better than chance, or $p \leq 0.2$.

H_a : The dowser's claimed ability is better than chance, or $p > 0.2$.

Although Wald suggests choosing values for P_0 and P_1 before α and β (16:89), there is no practical difference when these values are chosen if you understand their importance. Initially, α could be set equal to β. In doing this, one assumes that the effect of making either type of error is the same. Reviewing the errors shows that Type I errors are more serious, that is, will lead to further study and expense, than Type II errors. Hence, Type I error probability should be reduced to give more confidence in the results if the dowser's effort leads to rejecting H_0. Therefore, based on the previous discussion of Type I and Type II error and knowledge of typical values, set $\alpha = 0.05$ and $\beta = 0.10$. These values give acceptable confidence in the experiment's results and represent commonly used values.

Establishing P_0 and P_1 proves to be a matter of judgment. One can contrive a suitable combination that creates a small enough gray area to allow for around 30 trials before a 'chance' operator would be rejected. That is after 30 trials, the 'chance' operator should have guessed correctly about six times. At this point, the plotted data would break the 'Accept H_0' line and the experiment would be discontinued. Thirty trials was chosen at random. With β established, trial and error provides a value of $P_1 = 0.40$. This value would require the dowser to perform near this probability before the null hypothesis would be rejected.

Knowing that a value of P_0 close to the true probability would make a wider gray region, you could make the region sufficiently wide to require an excessive number of trials before rejecting the hypothesis. Doing so would only increase the effort required to test the hypothesis. Additionally, the stated purpose in using Wald's equations was to limit the number of samples. Without further guidance, the value for P_0 was based on a proportional evaluation of P_1. P_1 could range from 0.20 to 1.0. That is a range of 0.8. Twenty-five percent of that range, $0.8 \times 25\%$, is 0.2 and $P_1 = p' + 0.2 = 0.40$. Similarly, the value of P_0 is also 25% of the range it could take. The range is from 0 to 0.20, and $0.20 \times 25\% = 0.05$. $P_0 = p' - 0.05 = 0.15$.

With these values determined, Figure 9 shows the chart that will be used in this experiment. To recap, for the experiment the parameter values have been set at $\alpha = 0.05$, $\beta = 0.10$, $P_0 = 0.15$ and $P_1 = 0.40$.

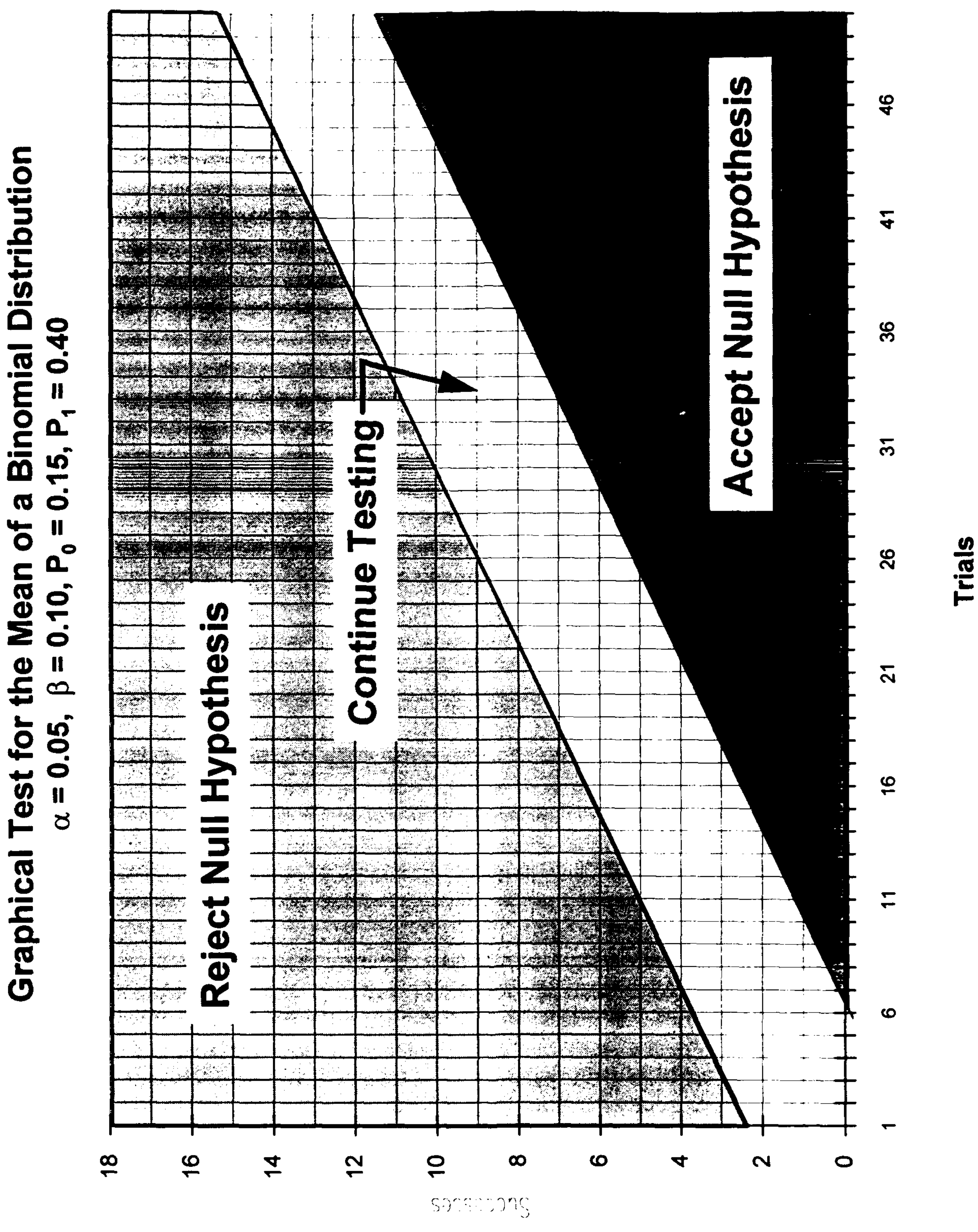

Figure 9: Experiment's Graphical Test

Chapter 4

Results

This chapter presents the results of a field observation used to learn about Mr. Carl's technique and the field experiment. It is organized chronologically and discusses an observation at a well site, the selection of the experiment site, setup of the equipment and conduct of the experiment.

Proposed Water Well Site, State Route 35, Urbana

A site visit was made at this location to witness Mr. Carl's dowsing process on 4 June 1994. The site was a two acre plot that rose from the road to a small plateau area. The owner wanted the well along the southern boundary of the site towards the front. The area for the well was sloping at about a 3:1 grade. Mr. Carl located three spots that he felt had veins of water running through them. He said the first location was not very "strong." He recommended the second location at which he said had two veins crossing, one at 60 feet and the other at 80 feet. The other point had the 80 feet deep vein and another vein running parallel to the first 60 feet vein at 61 feet. See Fig 10.

A follow-up was conducted on 6 June 1994 when the well was being drilled. The drilling rig operator had difficulty aligning the truck with the stake because of the grade. He placed the rig over the stake, but when it was leveled the well was spotted about three feet down gradient from the place marked by Mr. Carl. The location was close to the line of the 60 foot vein he had spotted. The rig was a mud rotary unit. Drilling time was about two hours.

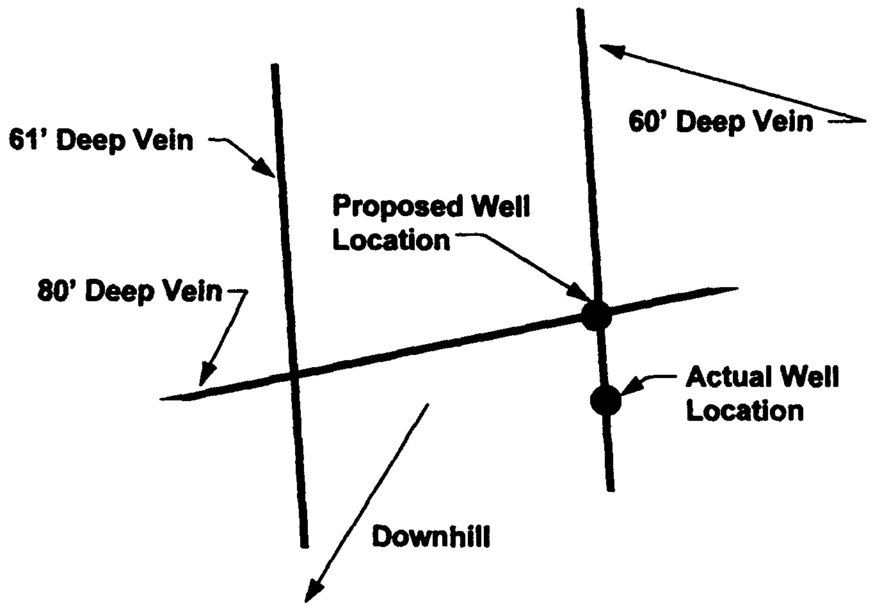

Figure 10: State Route 35, Urbana Site

The operator was attempting to locate a gravel lens at 95 feet. He had obtained his data from the state's geological survey on the site. He uses his experience to tell him what kind of material he is drilling through. For example, the drilling rig moves smoothly and steadily through a stiff clay. When the bit hits a rock, the rig reacts by 'jumping' about and shaking. When the operator hits gravel, the bit moves rapidly, the rig shakes and rattles, but the drive chains remain taught.

As the drilling passed 60 feet a rock or very thin layer of gravel was hit. The operator did not consider stopping at this location because he believed the obstruction was not a gravel lens that carried water. He continued drilling and located the gravel he was attempting to find at around 97 feet.

At that depth, he checked the well drillings to confirm that he was in gravel. He collected a sample and then washed it in a bucket of water. This revealed stones in the cuttings. He was satisfied that he had located the gravel lens and prepared to drive the well casing. The well casing was screened about eight feet. A screen is an area of the well casing that lets the water in the aquifer into the well to be pumped out. See Fig 11. This screen was about three feet from the bottom of the casing. The operator drove in five 5-inch diameter by 20 foot long sections of well casing. This established a 100 foot deep well.

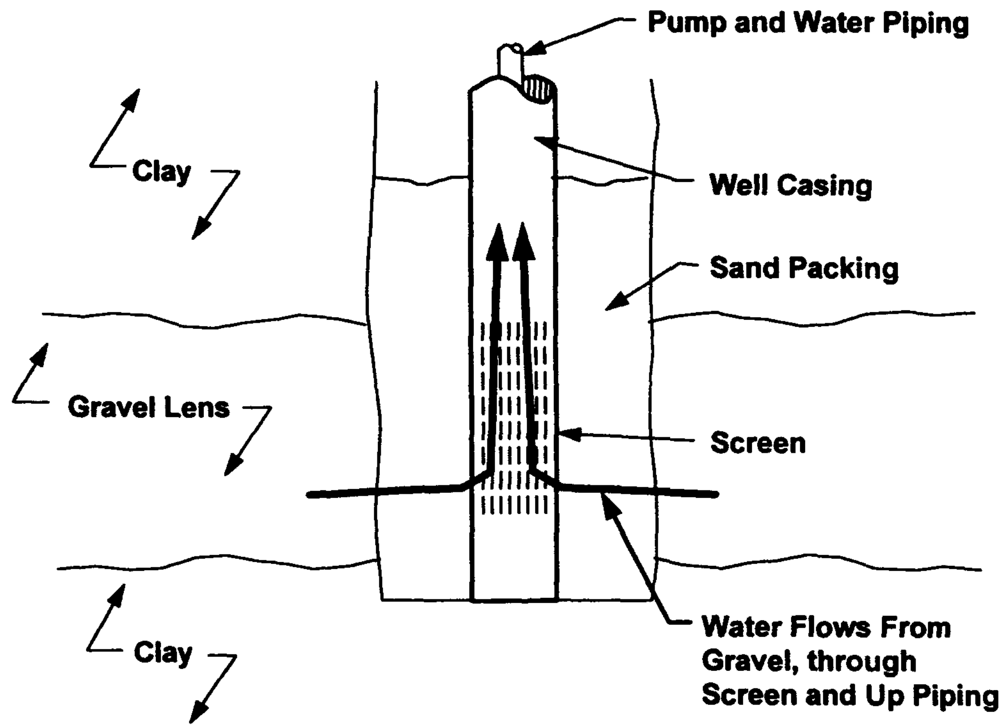

Figure 11: Typical Well Screen

The operator then purged the well to determine if the well was producing water. The well was purged by high pressure air driven through the bit shaft. Water was then forced out the well casing. If the well was not producing, the water would stop flowing out of the top of the casing. A producing well would provide continuous water flowing out of the casing. By the driller's estimate, the well was producing about 10 gallons per minute.

As far as this site is concerned, it provided little information towards proving or disproving the dowser's claim. The drilling did not take place at the location the dowser had marked. By his own accounting, you should drill at his marked spot or you will miss the 'vein.' Since the driller did not stop to see if there was water at 60 feet, there is no way to determine if the dowser had located a 'vein' there. Without better data, this site added only inconclusive information to the dowsing argument.

Selecting the Site

Selecting a site for the experiment proved to be a difficult task. Mr. Carl found numerous 'veins' throughout three prospective areas. Alternatives were discussed that required a reduction in the distance between the piping network. After looking at other sites an area was found, Figures 12 and 13, that Mr. Carl described as having parallel veins running north to south. They appeared to be regularly spaced. A baseline was established by placing two stakes 100 feet apart, approximately perpendicular to the 'veins'. A string drawn between the stakes defined a line and along the line stakes marked each vein.

The stakes ranged from about six to 12 feet apart. A portion of the line was selected where the stakes appeared to have the widest spacing. With the dowser's agreement that the water lines would be placed centered between the stakes and parallel to the veins.

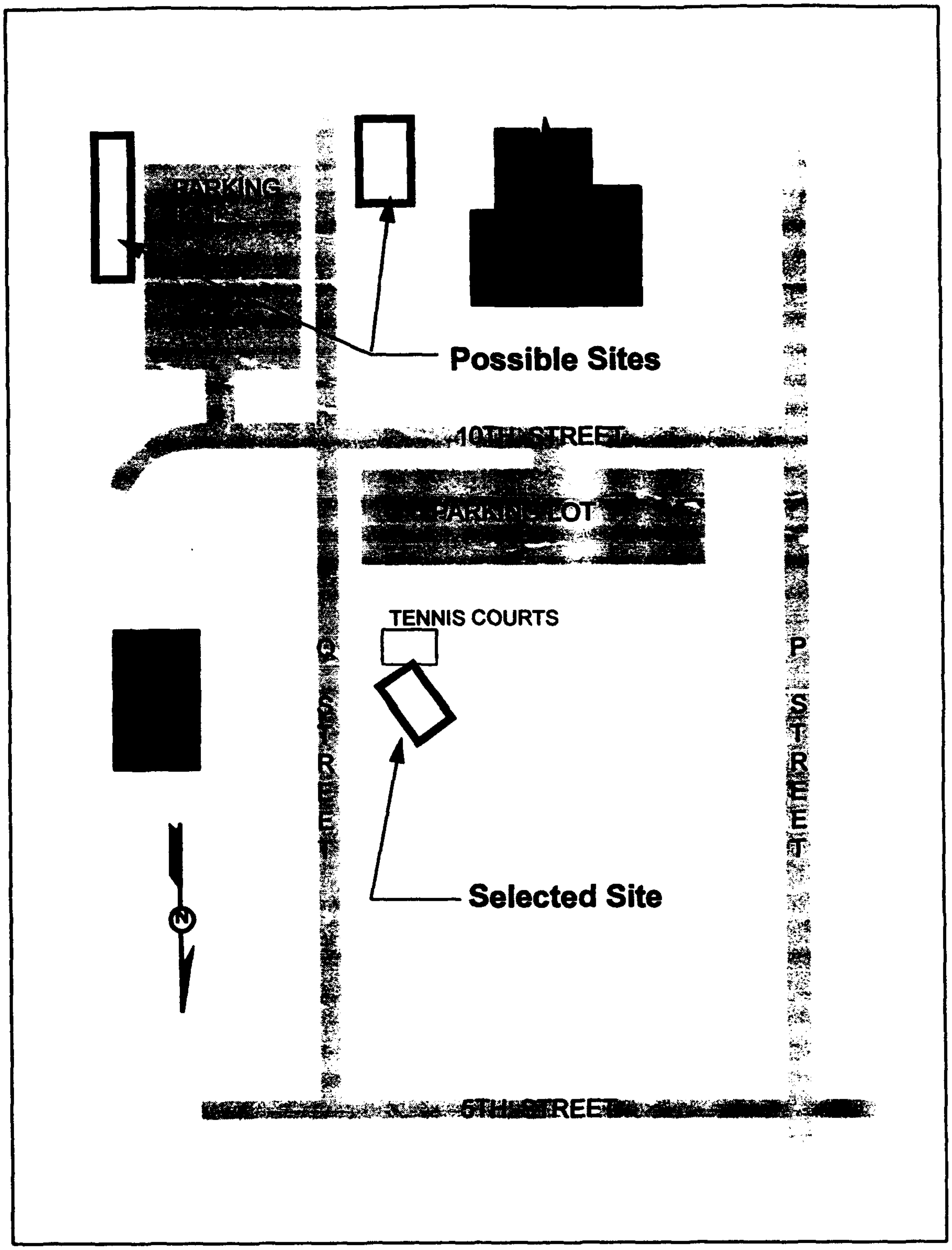

Figure 12: Site Location Plan

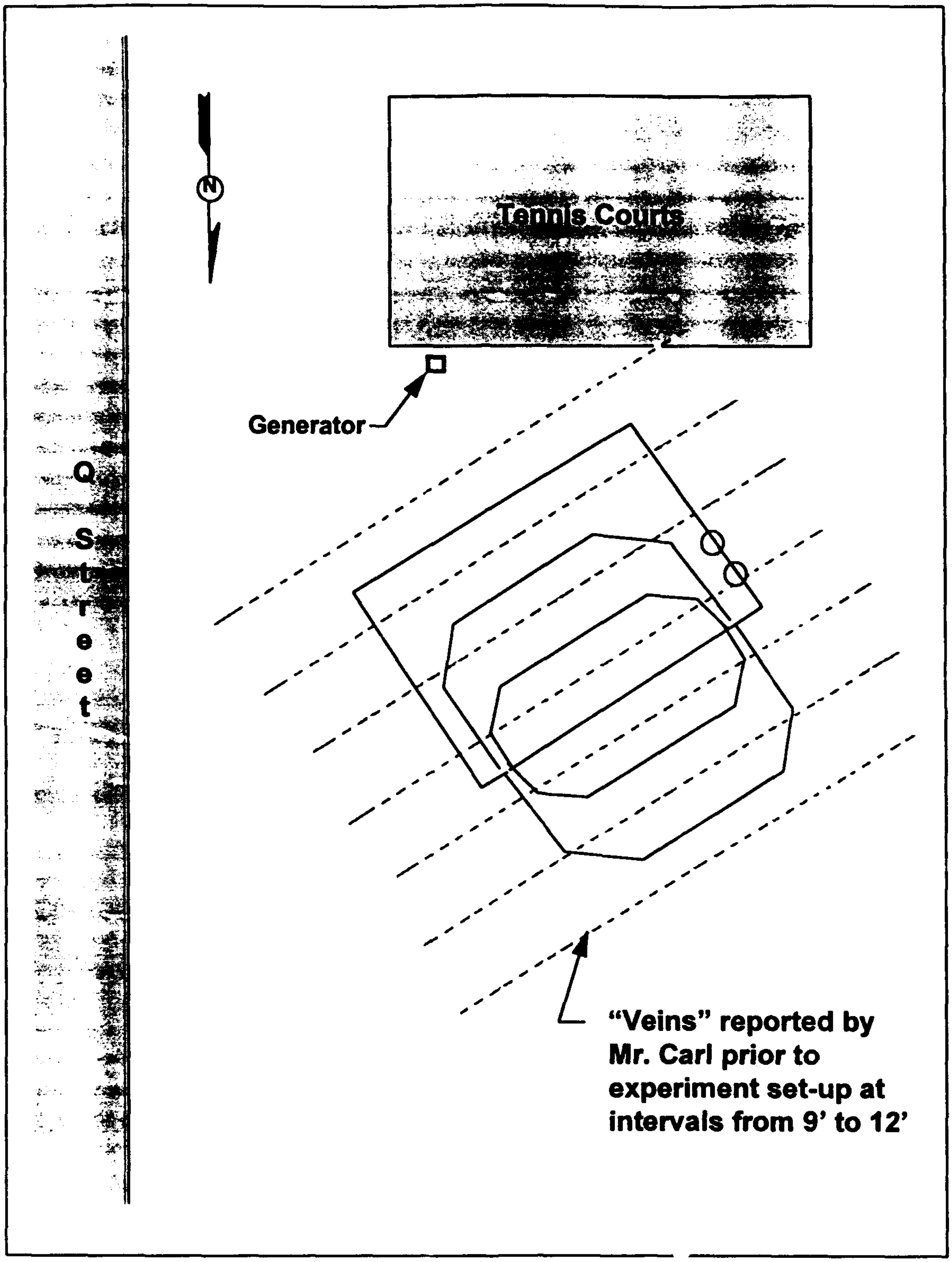

Figure 13: Site Layout Plan

Setting Up the Equipment

Appendix C lists the materials used in the experiment. Not all the materials procured were required because several things changed after the initial planning. First, the pump used in the experiment was not capable of producing a large volume of water. During a pump test to determine rates, the pump, rated at 24 gallons per minute (gpm) by the manufacturer, produced a little over 3 gpm. Upon investigation, the check valves used to keep water from back flowing through the system caused the reduction in pressure. When the check valves were bypassed, the rate jumped considerably. This issue was discussed with the dowser and he felt the lower rate might cause him some problem. To solve this issue an alternative manifold that eliminated the check valves if the need arose was provided.

The piping system was laid out the day prior to the scheduled experiment. Because of the locations of the 'veins', the overall system layout was reduced to approximately 10 foot spacing rather than the 20 foot spacing initially sought. The stakes that were placed to mark the veins were left in place and each line was placed at the midpoint of two stakes. Otherwise, system layout remained as designed.

A four foot high screen was built around Manifold 'A' to allow the manifold operator to sit behind it and be completely out of the dowser's sight. Tarpaulins were placed around the frame. As an additional safety measure, cardboard was placed over the manifold to insure shadows were not cast on the tarps from the valves.

Power for the pump was provided by a portable generator. It was placed approximately 70 feet from the pump, but close enough to the network to provide masking noise.

All observers checked the lines to insure there was no signal, such as sound or vibration, the dowser could pick up from the system. All agreed the system provided no information that could be used by the dowser to discern the correct pipe.

Conducting the Experiment

The field experiment was conducted on 16 June 1994. The day was a hot, sunny day. The temperature was in the high 80's and the relative humidity was over 90%. The experiment took about two hours to run. The dowser located the line with flowing water in 10 out of 27 trials. In doing so, the dowser broke the 'Reject Null Hypothesis' line indicating that Mr. Carl's skill is better than chance.

The experiment was observed by the four member thesis committee, the researcher and one disinterested person. The disinterested person and one committee member were used to operate the valves and record data at Manifold 'A'. All other observers and the dowser remained on the network side of the screen. This produced a double blind experiment situation.

The procedures were briefed to the dowser before commencing the experiment. All steps stated in the procedures were followed starting with step three since the first two steps involved set-up. The dowser was asked before he started if he had any questions or comments about the proposed experiment. He stated that he had no questions and that the experiment should be a good test of his skills.

Mr. Carl brought both a V-rod and angle rods to use for dowsing. Initially, he appeared to have no trouble with the V-rod, but had trouble as the experiment progressed. He said he was getting a reading from all the pipes and was having trouble discerning which was the correct pipe. This was contrary to his previous statement that he got no reading from still water. He was becoming tired from the heat and appeared frustrated at his inability to easily discern the correct pipe. Trials 11 through 17 had been failures (though no one but the operators knew this). Because of Mr. Carl's appearance, one of the observers suggested Mr. Carl take a break to rest and get something to drink. After this break, he quit using the V-rod and finished the experiment using angle rods. The dowser's performance improved considerably. He had three straight successes.

At trial 20, Mr. Carl said he knew that the line could not be a particular line because that line was just selected. At that time the researcher explained to him that each trial was independent and that any line could be chosen a number of times in a row, based on the random number tables. Although his performance was not perfect, he did seem to understand this issue. Trials 18 through 27 included only three failures. See Table 2 and Figure 14 for the results.

Mr. Carl's technique appeared straightforward. He started at one end of the network and when queued to go, he quickly walked across the pipes to the other end. On occasion, he returned to specific lines before stating his answer. He never touched any of the lines. He normally started at one of the 'veins' that were marked before the experiment and then paced across the piping. At times, he would stand sideways next to a line and then turn himself so that the dowsing rod would go over the line to get a response. While using the angle rods, Mr. Carl placed his thumbs over the rods to keep them from moving when he crossed one of the 'veins' he had located prior to setting up the equipment.

Afterwards, Mr. Carl was debriefed about the proceedings. He classified the experiment as a good experiment. When asked about the random order issue, he stated that he did not understand the point initially and it had confused him during the early portions of the experiment. This caused him to guess more often when he could not easily tell which pipe was running. He could not explain why he was having trouble with the V-rod. He did remark that the branch was not freshly cut, indicating by his words that there was some importance to the issue.

The significance of these and others issues requires further analysis. The next section provides this analysis.

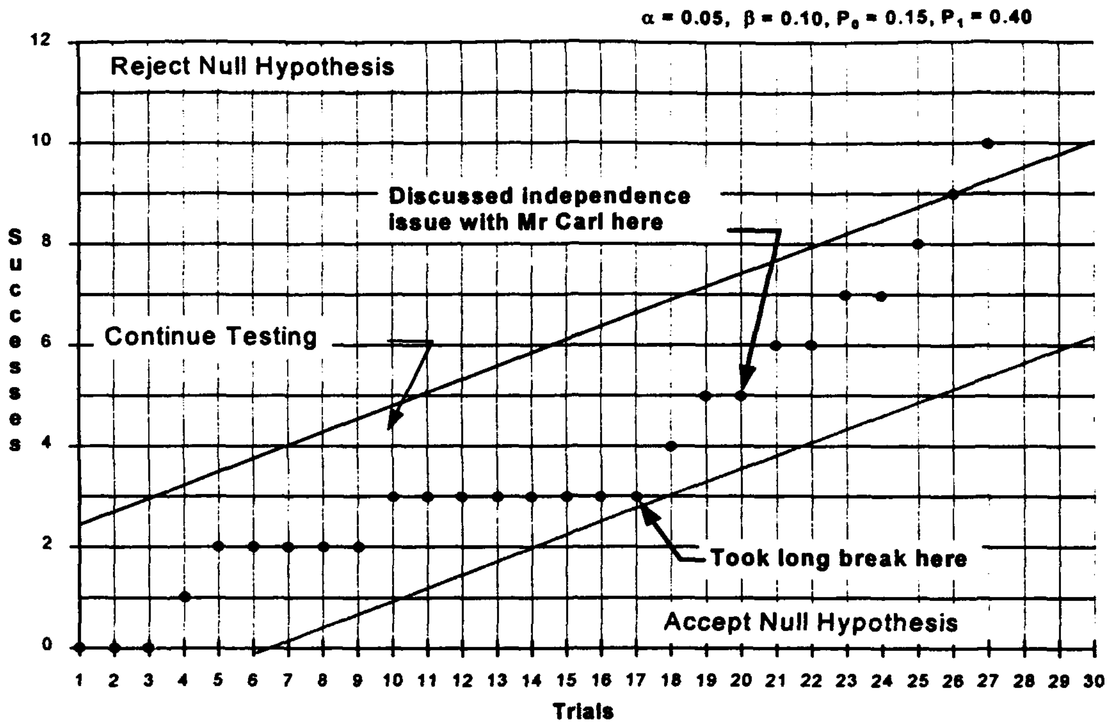

Figure 14: Graph of Experiment Results

Table 2: Experiment Results								
Trial	Valve Opened	Mr. Carl's Pick	Trial	Valve Opened	Mr. Carl's Pick	Trial	Valve Opened	Mr. Carl's Pick
1	1	4	10	5	5	19	1	1
2	3	2	11	5	2	20	2	5
3	3	4	12	1	5	21	5	5
4	3	3	13	3	4	22	2	1
5	5	5	14	2	3	23	3	3
6	1	2	15	3	5	24	1	4
7	2	5	16	5	2	25	2	2
8	1	3	17	2	5	26	5	5
9	2	1	18	2	2	27	1	1

Chapter 5

Analysis and Conclusion

The results of this experiment were unexpected. After conducting the initial research, this researcher believed the experiment would quickly conclude with data supporting the null hypothesis, that is, the dowser was no better than chance. Mr. Carl's performance surprised everyone attending except the dowser himself.

This section analyzes the experiment, discusses the implications of these results, recommends further study and provides concluding remarks for the research.

Analysis of the Experiment

Analysis of the experiment requires review of the experiment with respect to the process and analysis of the data from the experiment. Four aspects of the experiment process will be reviewed: appropriateness of the experiment process, failure to explain random procedures and trial independence to the dowser, implications of taking the break at Trial 17, and changes in the parameters and how they would effect the results. The experiment process will be reviewed first.

Experiment Process

All observers agreed before the experiment that the set-up did not provide the dowser with any inadvertent cueing. One observer instructed the researcher to do a post-experiment interview with the dowser to be sure to get his after-the-fact feelings on the adequacy of the experiment. The intent, expressed to the researcher, was to obtain feedback from the dowser on why he failed. The feedback would provide a basis for countering any arguments presented by the dowsing community as to the inadequacy of the experiment. Since the results indicated rejection of the null hypothesis, the post-experiment interview required only questions on the issue of independence and what had happened at the time of the break at Trial 17.

The placement of the observers proved fortuitous. The researcher planned to have the assistant at the control manifold. One of the observers volunteered to sit with the assistant at the valves to provide oversight. This observer was a known skeptic. By being there, it can be assumed that the operation of the valves was proper and according to the experiment protocols.

The remaining observers, the researcher and the dowser remained on the network side of the screen. Care was taken to insure that no one could discern what was going on at the valves. Because of this, there could not have been any inadvertent cueing on anyone's part to clue the dowser into which line to select. These features insured the experiment was carried out in a double blind fashion.

The set-up provided only three options for the dowser to select the proper line: guessing, dowsing or trickery. If trickery could be eliminated, then the experiment would have met all the requirements defined by skeptics like Randi and Vogt & Hyman. Analysis of the set-up, operation, placement of observers and observation of the dowser leads this researcher to conclude that no trickery took place. The piping system was checked for leaks before the start of the experiment. All joints were solid. The pipes were checked for signs of vibration that may be sensed by the dowser. None of the observers felt vibrations in the pipes along the dowser's pathway. There was a small vibration noticeable at the valve manifold, but because of the distance from the dowsing pathway and the flexibility of the piping, it was dampened before reaching the pathway. One observer paid particular attention to watching if the dowser touched any of the lines. At no time was the dowser observed touching a line. The dowser could not hear the water running because the system was extremely quiet, the flow rate was low enough to limit noise and the generator provided considerable masking noise. All known avenues for trickery were eliminated. With dowsing or guessing as the only two options, one can be confident in the results.

Failure to Explain Random Procedures

By failing to explain the issue of a random procedure to the dowser two issues surface. First, what was the effect of this misunderstanding on Mr. Carl's effort. In answering the questions, Mr. Carl expressed that he did not understand the issue of independence before the experiment started and did not fully understand it even after the initial explanation was provided at Trial 14. It was not until the second explanation was provided that he understood the issue. Between the first and twentieth trials, Mr. Carl faced five occasions (trials 7, 11, 15, 16, 17) where the line that was flowing was the same line he had previously picked. If these trials were removed from the analysis the results would not have changed, but the experiment would have concluded earlier providing the dowser with a better overall performance of 0.45.

The second issue of this aspect deals with a breach of protocol in scientific process. By talking to the dowser, the researcher interrupted the experiment. It should have proceeded to its conclusion without the explanation being given. Many would say this would invalidate the entire experiment. The researcher should have insured the dowser understood a random experiment. In defense of this breach, there was no intent to interfere with the results by providing the information. And again, removing the instances where the dowser was faced with a flowing line identical to the previous line selected would not change the results. In addition to the five trials mentioned earlier, the dowser faced only one more incidence of duplicate line selection. If one assumes that Trial 21 should have been a failure, the dowser still would have broke the "reject null hypothesis" line if his trend of successes continued. These two possibilities are shown in Figure 15. Note, however, neither of these alternatives proves adequate. Messing with the data set only leads to further non-productive speculation on the results.

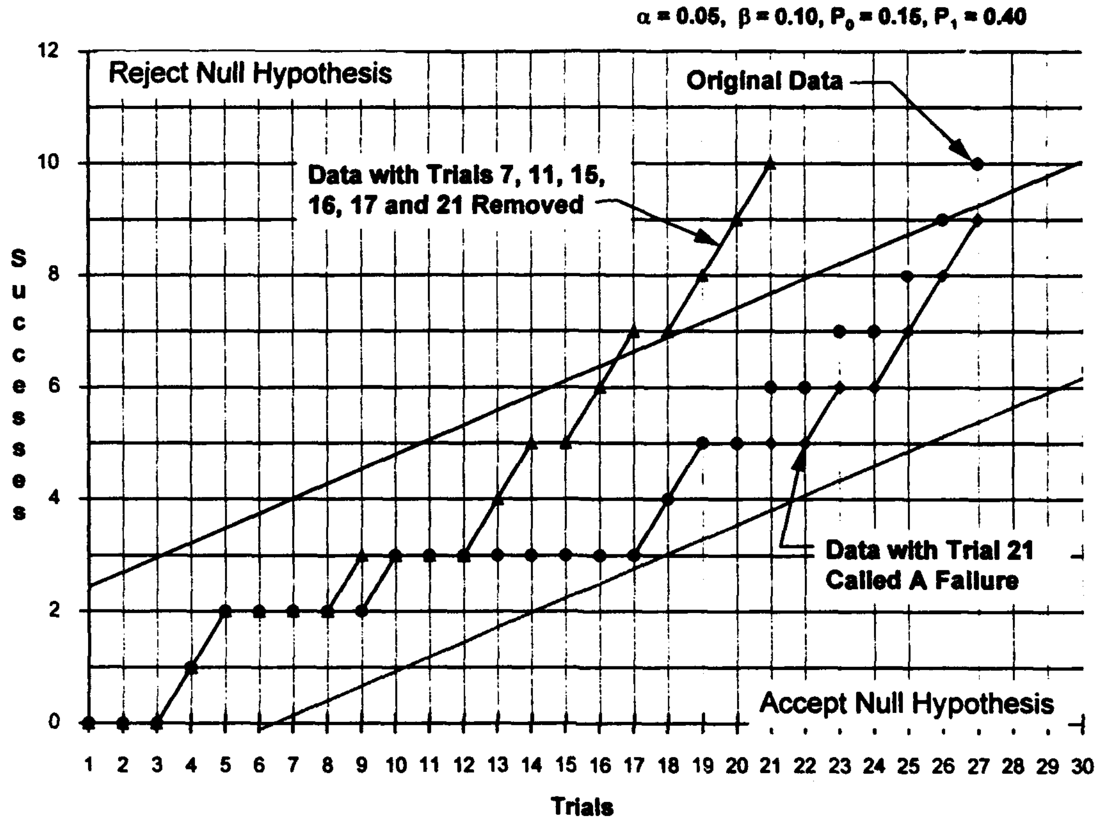

Figure 15: Experiment Data Plotted with Removed Trials

The Break at Trial 17

The break that was taken at Trial 17 could not have come at a better time for Mr. Carl. If he had continued at the pace he had set in the previous seven trials, the experiment would have ended with the opposite conclusion. An after-the-fact analysis of the parameters shows that a small change of P_1 to 0.43 or β to 0.15 would have caused Mr. Carl to break the "Accept Null Hypothesis" line. When asked about the break, Mr. Carl stated that he was feeling extremely fatigued prior to the break. Choosing a line was taking additional effort because all the lines were giving him a reading. During the break

Mr. Carl decided he was not getting a clear signal from the V-rod and stopped using it. His effort improved considerably and during the last ten trials Mr. Carl pick the correct line 70% of the time.

Changes in the Parameters

As stated earlier, small changes in P_1 and β would have caused the dowser to break the "accept null hypothesis" line at Trial 17. Figure 16 shows these changes graphically.

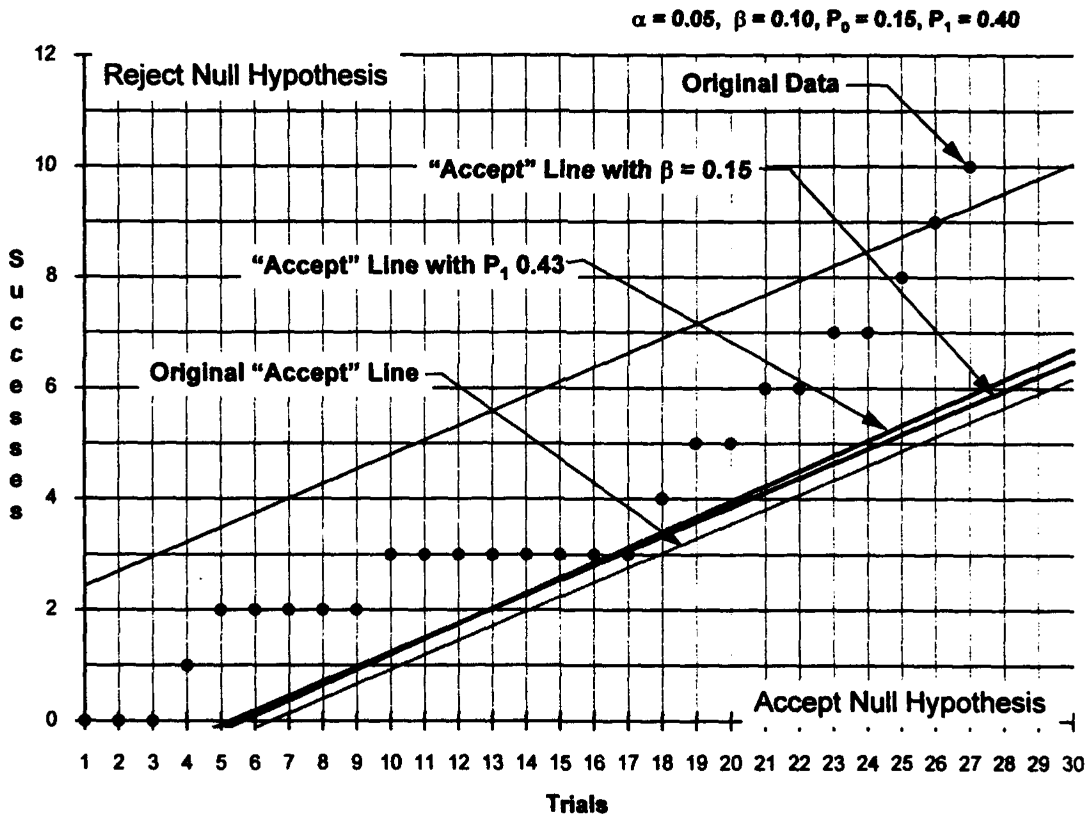

Figure 16: Experiment Data Plotted with Changed Parameters

The values for these parameters could be scrutinized for the near failure at Trial 17. For the value of P_1, the seemingly small change may lead one to suggest a higher value should have been chosen. However, remember that the experiment was designed to see if the dowser was better than chance. The value of P_1 defines a breakout point where you would reject the null hypothesis. It would be unreasonable to increase the value. The test already requires the dowser to perform nearly twice as good as a known guesser would perform. To require the dowser to perform to a higher standard for this experiment is not necessary.

Changes to the value of β may also be suggested. Recalling that β is the probability of accepting the null hypothesis when the alternate hypothesis is true, changing the value would only increase your chance of accepting the wrong hypothesis. Although the dowser's claim would have been refuted. one could not be as confident in the results. Additionally, it could be argued that increasing the value of β while maintaining or reducing the value of α is stacking the experiment against the dowser. Doing so would destroy any objectivity the experiment has maintained.

Implications of the Results

The results of this experiment will be controversial. Prior to this experiment, there has been no empirical data to support the notion of dowsing. If one believes this data and the previous conclusions then the data directly supports the notion. The statistics indicate, with a 95% confidence level, that Mr. Carl can dowse for flowing water in a network system and better than one could who operates by chance. Discussion of the implications of the results will provide a basis for further study into the experiment and its results.

The experiment did not prove that a dowsing sense exists. As a preliminary study, caution must be used before making such a claim. The experiment *does* provide support for the notion of dowsing. Mr. Carl appears to have a unique skill. However, there was no data collected that indicated that his skill was any better than the skill of a trained geologist, hydrogeologist or well driller at locating the best place for a water well.

These results suggest much more work needs to be done regarding this phenomenon. Additional experiments following the procedures established herein should be conducted on Mr. Carl and other reputable dowsers. Revisions to the experiment may be warranted and may provide different results. Refinement and agreement on different values for parameters used in Wald's equations should occur. These items need to occur before this experiment can be classified as a repeatable experiment that provides consistent results.

Mr. Carl's claim to be getting readings from the stagnant water lines was contrary to an earlier claim that he got no reading from still water. Prior to the experiment, the dowser had commented on this as a possible problem. He had explained to the researcher that he tried to locate water in a hose at his home. He said he was getting a reading from the hose even after it had been drained of water. This apparent inconsistency was interpreted by the researcher, before the experiment, to be the basis for a future "explanation" as to why the dowser could not do better than chance in the experiment. Since the dowser did better than chance, no one will know if this was to be the basis for a failure excuse.

Conclusion

Mr. Lewis Carl has shown this researcher that he has a unique skill. During the course of the study, both points of view regarding dowsing were accepted as plausible at some time or the other. Vogt and Hyman's *Water Witching, U. S. A.* seemed to close the discussion on the subject. Their conclusions are compelling and anyone who reads their work should come to the same conclusions.

Meeting and watching Mr. Carl allows one to witness a man who truly believes in his ability, has set very specific limits on its application and refuses to believe many of the claims other dowsers report to have accomplished. Several things that Mr. Carl does while dowsing don't fit into many of the definitions that have been proposed. For example, during one of the times Mr. Carl was dowsing, the researcher videotaped his hands to see if there was any movement of the hands that would cause the v-rod to turn. Though there was no formal evaluation other than slow motion observation, this researcher could not detect any motion of the hands other than would occur while he walked. On another occasion, Mr. Carl stated that the rod make a noise while it turned in his hands. The noise, similar to one made while gripping a finger in the palm of one hand and then twisting the finger, could be clearly heard, but not explained.

There are many aspects of dowsing that were not addressed by this experiment and these results do not apply to them. Additionally, many people claim to have a dowsing sense but are not reputable. Beware of anyone who wields this work as proof of their skill. As in any scientific experiment, repeatability, under the scrutiny of the scientific community, is the determinant of valid results. Unless this validation occurs, these findings will remain experimental data.

These things combined with the results of the experiment suggest that something has occurred that cannot be explained. Additional research as suggested earlier is required to substantiate that a dowsing sense could exist.

Appendix A

Books Covering the Subject of Dowsing

Source: The FirstSearch™ Catalog, Worldcat Database

Author	Title	Place	Publisher	Year
—	Before you hire a "water witch"	Worthington, Ohio :	The Association,	1978
—	Jacob's rod a translation from the French of a rare and curious work, A.D. 1693, on the art of finding springs, mines and minerals by means of the hazel rod. To which is appended researches, with proofs of the existence of a more certain and far higher Faculty, with clear and ample instructions for using it.	Boston,	A.H. Roffe & Co.,	1887
—	The Forces behind divining	London :	Markham House Press,	1945
Allen, John, 17th cent.	Judicial astrologers totally routed, and their pretence to Scripture, reason & experience briefly, yet clearly and fully answered, or, A brief discourse, wherein is clearly manifested that divining by the stars hath no solid foundation ...	[London] :	Printed for John Allen ...,	1659
An element of the divine	Beverly Hills, CA :	Pacific Arts Video,	1990	Audiovisual
Bachler, Kathe, 1923-	Discoveries of a dowser : results of research on more than 3000 apartments, houses, and work places : the recognition and correction of geopathic disturbances of sleep, health, and school performance	Linz, Vienna, Passau, Austria :	Veritas Publishing House,	1984

Bailey, Richard N.	Dowsing and church archaeology	Wimborne :	Intercept,	1988
Banister, Manly Miles, 1914-	Mirabile dictu; the philosophy of the divining rod.	Kansas City, Mo.,	Nekromantikon Press,	1951
Baring-Gould, S. (Sabine), 1834-1924Hartmann, Franz, d. 1912.	The principles of astrological geomancy; the art of divining by punctuation, according to Cornelius Agrippa and others.	London,	Theosophical publishing company,	1889
Baring-Gould, S. (Sabine), 1834-1924.	Curious myths of the Middle Ages	London : New York :	Rivingtons ; G. Routledge,	1867
Barrett, William, Sir, 1844-1925.	On the so-called divining rod, or virgula divina : a scientific and historical research as to the existence and practical value of a peculiar human faculty ...	London :	Kegan Paul, Trench, Trubner,	1897
Barrett, William, Sir, 1844-1925.	The divining rod : water-divining thoroughly explained	Toronto :	Coles,	1979
Barrett, William, Sir, 1844-1925.	The divining-rod; an experimental and psychological investigation,	London,	Methuen & co, ltd.	1926
Baum, Joseph.	The beginner's handbook of dowsing; the ancient art of divining underground water sources,	New York,	Crown Publishers	1974
Beaven, E. W.	Tales of the divining rod.	London,	A.H. Stockwell & co.,	1899
Benjamine, Elbert.	Divination	Los Angeles, Calif. :	Church of Light,	1940
Besterman, Theodore, 1904-1976.	Water-divining; new facts and theories,	London,	Methuen	1938

Bird, Christopher, 1928-	Divining : the art of searching for water, oil, minerals, and other natural resources or anything lost, missing or badly needed	London :	Raven Books,	1979
Bird, Christopher, 1928-	The divining hand : the art of searching for water, oil, minerals, and other natural resources or anything lost missing, or badly needed	New York :	Dutton,	1979
British Society of Dowsers.	Journal	Lindfield, Eng.		
Cameron, Verne L., 1896-	Aquavideo : locating underground water through the sensory - eye of Verne L. Cameron	Santa Barbara, Calif. :	El Cariso Publications,	1989
Cameron, Verne L., 1896-	Map dowsing	Santa Barbara, Calif. :	El Cariso Publications,	1971
Cameron, Verne L., 1896-	Oil locating.	[Elsinore, Calif.]	El Cariso Publications,	1971
Chamberlain, Toby.	Basic dowsing for fun and profit	Glendale, Calif. :	Dowsers International,	1981
Chambers, Howard V.	Dowsers, divining rods, and water witches for the millions,	Los Angeles,	Sherbourne Press	1969
Cook, Albert Alfred.	Radial detection, a guide to the use of the radial detector, mis-called the divining rod.	Sydney,	Angus and Robertson,	1941
Cookes, Howard St. L.	The eyes, brain & nerve system in relation to the earth's magnetism : an explanation of why the dowser's pendulum and other media move, and other phenomena	Bidefore, Devon :	Devon Rustics,	1971
Copen, Bruce.	Dowsing from maps : tele-radiesthesia	Haywards Heath :	Academic Publications,	1975
Cotton, Louise.	Palmistry and its practical uses, to which are added chapters on astral influences and on the use of the divining rod,	London,	G. Redway,	1890

Cox, Bill, 1921-	Techniques of pendulum dowsing	Santa Monica, Calif. :	Forces,	1977
Davies, Rodney.	Dowsing : Ancient origins and modern uses.		Aquarian Press (HarperCollins),	1991
Decremps, Henri, 1746-1826.	White magic revealed, or, An explanation of surprising tricks which have lately been the admiration of the capital and the provinces : with reflections on the divining rod, automatic chess p;ayers [sic], etc.			1900 1958
Dobler, Paul E.	Biophysical studies of radiation from matter, divining rods and electrical waves	Gainesville, Fla. :	Agricultural Research, Southern Region, SEA, USDA,	1980
Eerenbeemt, Noud van den.	Divination by magic	York Beach, Me. :	S. Weiser,	1985 1982
Elliot, J. Scott.	Dowsing one man's way	London :	Sphere,	1979 1977
Ellis, Arthur Jackson, 1885-	The divining rod, a history of water witching,	Washington,	Govt. Print. Off.,	1934
Ellis, Arthur Jackson, 1885-	The divining rod, a history of water witching, with a bibliography,	[Folcroft, Pa.]	Folcroft Library Editions,	1975
Fairholme, George, 1789-1846.	On the use of the divining rod or virgula divinatoia (la Baguette Divinatoire) in discovering springs of water & in tracing metallic veins	[Illinois? :	s.n.],	1985
Fischer, Ernest G.	The mysteries of water witching.../	Austin, Tex. :	The Texas Star,	1972

Foord, Richard.	Teach yourself divining for underground water, minerals and pipes etc. using wires and pendulums	Maiden Gully, Vic. :	R. Foord,	1990
France, Henry de, vicomte, 1872-	The elements of dowsing	London :	G. Bell,	1948
France, Henry de, vicomte, 1872-	The modern dowser : a guide to the use of the divining rod and pendulum	London,	G. Bell & Sons,	1936
Franklin, Stephen E., 1946-	Origins of the tarot deck : a study of the astronomical substructure of game and divining boards	Jefferson, N.C. :	McFarland,	1988
Geological Survey (U.S.)	Water dowsing.	[Reston, Va.] :	Dept. of the Interior, Geological Survey,	1977
George, Karl, 1902-	Dowsonology *: the quick route to better health*	Laurel, Mont. :	[s.n.],	1974
Geree, John, 1601?-1649.	Astrologo-mastix, or A discovery of the vanity and iniquity of judiciall astrology, or divining by the starres the successe, or miscarriage of humane affaires ...	London,	Printed by M. Simmons, for J. Bartlet,	1646
Graves, Tom.	Discovering dowsing : understanding and using the power of diviningOriginally published as: The dowser's workbook, 1989.	London :	Aquarian,	1993 1989
Graves, Tom.	Dowsing : techniques and applications	Harmondsworth, Eng. ; Ringwood, Vic. :	Penguin Books Australia,	1977
Graves, Tom.	Dowsing : techniques and applications	London :	Mayflower,	1980 1976
Graves, Tom.	Needles of stone revisited	Glastonbury :	Gothic Image,	1986

Graves, Tom.	The Diviner's Handbook.	New York, NY :	Warner Books,	1977 1976
Graves, Tom.	The diviner's handbook : your guide to divining anything from lost objects, precious metals to the mysteries of your own mind	New York :	Destiny Books,	1986
Graves, Tom.	The dowser's workbook : understanding and using the power of dowsing	Wellingborough :	Aquarian,	1989
Gregory, J. W. (John Walter), 1864-1932.	Water divinging.	[London,	Knapp, Drewett & sons, ltd.	1927
Gregory, J. W. (John Walter), 1864-1932.	Water divining,Smithsonian Institution. Annual report, 1928.	Washington, 1929.	GPO	1929
Guth, Steven.	Pendulums : dowsing with a pendulum, the pendulum in the garden	Curtin [A.C.T.] :	Bindu Manuscripts,	1986
Hall, James, 1793-1868.	Legends of the West ...	Cincinnati,	Robert Clarke & co.,	1885
Hammerly, Clyde Clinton.	What and how about "water witching"? Facts learned from personal experiences in water "witching" or "divining",	Pittsburgh,	R. L. Hammerly, sr.,	1935
Hartmann, Franz, d. 1912.	The principles of astrological geomancy. The art of divining by punctuation, according to Cornelius Agrippa and others.	Boston, Mass.,	Occult Publishing Co.,	1889
Hester, Ben G.	A good hard look at dowsing	Payson, Ariz. :	Leaves of Autumn Books,	1982
Ing, Robert S.	The Chinese divining pendulum	Toronto :	R.S. Ing,	1986
John Mullins & Sons.	The divining rod : its history, truthfulness & practical utility	Wiltshire, [Eng.] :	J. & H.W. Mullins,	1900

Kenney, Marie.	Dowsing with Clarence	Deerlodge, Mont. :	Platen Press,	1987
Lang, Andrew, 1844-1912.	Custom and myth	New York :	Harper & Bros.,	1885
Latimer, Charles, 1827-1888.	The divining rod virgula divina--baculus divinatorius (water-witching)	Cleveland, O.,	Fairbanks, Benedict & Co.,	1876
Lehr, Jay H., 1936-	Water witching : antiquated American folk lore.	[Dublin, OH :	National Water Well Association,	1980
Lethbridge, Thomas Charles.	Ghost and divining-rod,	New York,	Hobbs, Dorman	1967 1963
Lonegren, Sig.	Spiritual dowsing	Glastonbury :	Gothic Image,	1986
Maby, Joseph Cecil.	The physics of the divining rod being an account of an experimental investigation of water and mineral divining,	London,	G. Bell and sons ltd.,	1939
MacLean, Gordon.	A field guide to dowsing : how to practice the ancient art today	Danville, Vt. :	The American Society of Dowsers,	1976 1971
MacLean, Gordon.	Dowsing : an introduction to an ancient practice	[South Portland, Me. :	s.n.],	1971
MacLean, Gordon.	Dowsing, a book of instruction.	South Portland, Me.,		1971
Mager, Henri, b. 1859.	Water diviners and their methods	London,	G. Bell and sons ltd.,	1931

Mark, Jan.	Aquarius	Harmondsworth, Middlesex :	Kestrel,	1982
McIvor, John A.	Divining in Ireland	Dublin :	G. Dalton,	1980
McKusick, Charmion R.	How to dowse and balance the chakras	Globe, Ariz. :	Biomagnetic Research,	1991
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Appendix B

Interview with Jessie Aites

Gaisford: Mr. Aites, my mother-in-law tells me you are a dowser. Can you tell me about your skill?

Aites: I've been doing it for 50 years. I got the first nickel to take in. I don't charge no how. So, now I've been doing it for, I'm 72, I've been doing it since I was 21 and I've never missed.

Gaisford: What do you dowse for?

Aites: Water, oil, you name it.

Gaisford: Have you been used a lot around here for oil?

Aites: I had to quit doing it for oil. I used to do it an awful lot for oil but I got probably seven or eight thousand water wells. Never missed. I tell where its at, how deep it is, how much its making, what color it is, everything.

Gaisford: Can I go back and get some biographical data? How old are you sir?

Aites: I'll be 72 in August.

Gaisford: And you said you were 21 when you started, so that should help me pretty good.

Aites: 21 when I started.

Gaisford: How did you get involved with dowsing?

Aites: Well...you just want me to go back to when I got started?

Gaisford: Yes, what got you interested and how you figured out you had a gift.

Aites: Well, the way I figured out. I didn't figure it out. I was told I had it. My wife's grandfather, he was a water dowser for years. He lived to be 96 and he was still doing it when he died. But one day, it was shortly after we got married. That was 50 years ago. Anyhow, he was at her brother-in-law's finding water out in Ten Mile Bottom, about ten miles from here. And I went out. And Wayne Millright went out and he was finding water for her brother-in-law. He found the water and told them how deep it was. He said to me, he said, he handed me the limb and said, "Here, see if it works for you." I took a hold of that limb and I started across about where he was and I fell down. Here it paralyzed my body. And so I've been doing it since that, to this day.

Gaisford: What's your primary technique? What branch do you use, willow or any kind of branch?

Aites: Well, no not any kind. Willow works, but I like peach the best because I got all them peach trees around here to trim. But I use wild cherry.

Gaisford: Do you tape the ends together or do you find a special branch?

Aites: I use Y's, and I don't have to. The only reason you use a Y is so the other person can see it. I can use one inch of a peach branch and do the same thing I do with a limb. You probably know what a limb is.

Gaisford: Yes sir.

Aites: Okay, I use that. That's just for you to see. I'll take one inch of it and hold it between my two hands and I can tell you exactly where that water is by holding that one limb. You don't see anything.

Gaisford: You can feel it rotating.

Aites: Its in my body.

Gaisford: What do you think does it?

Aites: Its a gift from God. No kidding around. That's what does it.

Gaisford: Have you ever tried to talk to anyone else who dowses and understand what they have that you might have?

Aites: Oh yes. Well, they say the same thing. Its a gift from God. There's no other way. I have two sons and I'd love to have one of them be able to do it. If I could pass it on any way. But there's no way you can. I've been doing this for years now and I only ran into actually about four who could do it. (Simon, his seeing eye dog, approaches and Mr. Aites tells him to sit.) No, I only ran into about four that could do it. But the way it works for them, it works for me. There's no getting around it, it works. And I can find oil the same way. It works the branch different but I can tell oil, lead, or water anytime.

Gaisford: Does the water have to be flowing for you to detect it?

Aites: Naturally, water is flowing all the time. If its not , its no good.

Gaisford: Well, the man I'm working with said that he could approach a swimming pool and he could not tell the pool was next to him.

Aites: Oh no, I can't tell if its a swimming pool.

Gaisford: Cause its not moving water?

Aites: It won't pick it up. For a matter of fact, right here in the Allegheny River, I found an underground vein under it. The top water is moving. I can't tell that but I can find the water vein underneath it.

Gaisford: How do you determine depth?

Aites: Well, I have about three ways to do it. The way I go over it. As many times...each time I walk over the vein of water the limb goes down. And I keep doing that. Count one, two, three, four whatever it is. And when it quits going down, I take three times whatever it is. Three times three. Three three's are nine. It's nine feet deep. If its thirty, its three time it, you know. That's the way I determine. And it works. I never miss I missed at one time by two feet right down here at my neighbors. Oh, about ten or fifteen years ago. I went down and told him his water was 167 feet. He come up about a week later, knocked on my door and says "you missed." And I said, "Maybe I can't get them all. How much did I miss it?" He said, "Well, I never got water until I was 169 feet." I missed it by two feet. (Chuckles) Now, whether the driller measured it at the top of his pipe or down to where he found the water, but I measure from where I stand, from my feet down. And he was actually put out because I missed it by two feet. So now, I have a thing. I tell them. I go out and find them water and I say its "thirty feet," thirty feet, one way or the other. (Chuckles) So, that's the way...cause...you know when a driller sometimes puts a pipe in the ground, it sticks out two feet. He measures that two feet there. He's doing it for the money, by the foot. So I really don't know how this man down there measured it.

Gaisford: Do you have any well drillers that use you as a consultant?

Aites: Oh yes. Well, I have the Harry Brothers. I don't know if you know them or not. There down there out of Franklin. They have drilled quite a few that I have found. As a matter of fact, they used to go to people and they would want a well drilled and they would say, "Well, to save you some money, why don't you go and get a hold of Aites. And then we'll know exactly how much its going to cost before we start." There's different ones. Over in Clarion there's the Tiger Brothers. They call on me every once in a while. Different ones.

Gaisford: The reason I'm asking that question is because I'm doing some research and perhaps the well drillers have documented what you told them in their drilling logs. If they have kept something, I can get that and use that as backup for what you have told me. Not that I doubt your word, it helps to have some written...

Aites: Like I said, I don't charge a nickel for this. I never did and I don't think I ever missed. I can show you papers here, newspaper clippings with drillers that go and drill it and they already know before they drill how far its going to be because I told them. That's right in the paper. Then they go ahead and drill its in...I don't know if you ever heard of Don Riggs on television or not.

Gaisford: No, its not familiar.

Aites: He made a movie. Its a 22-minute movie. Made it for KDKA Pittsburgh. They went out here a couple of miles, about five miles from here, I guess. And we determined how deep it was going to be before the news, KDKA, came out to take the movie. Went through all that. And it was on the air, it had to be, like you said...like...go and question someone else about it. And it had to be that way for television because, boy, you'd be surprised the people who wrote into there and questioned them. So a... this one a...boy this one fella I used to go so many times. I think he's dead now. He's a water driller. I can't think of his name now its so many years ago. Anyhow I had a good many drillers come get me and didn't even want the water. But they would come and get me and have me go and measure it. And they would drill it to make sure it was going to be there before they would charge people for what I was telling them. (pause) Continental Can, I found water for them. I used to work for Continental Can. Our water bill down there was running us three hundred, three hundred and eighty-two dollars a month. A water bill for in the plant, water and sewer. Pat Cohen, the manager, he come out and said, "Jess if we have to pay this water bill every month. Its $380 now a month and its going up. We can't hardly afford that. Can you find us a vein of water?" I told him "I don't know why not." He told me to bring a limb down to the shop. I took a limb down about a week later and I went outside the building and I found them a vein of water, 57 feet deep. I told them, I said "Right here is the spot. Its 57 and a half" 57 feet I told them. And okay, they called a driller in and they come down and he said, "I want this..." Pat Cohen said, "I want this well drilled right here." "Why do you want it drilled here?" He says, "Jess Aites come down here and found the water vein. Its 57 feet deep." And he says, "No I won't drill it for you. I won't have anything to do with it." Pat says, "Why? You drill water?" And he says, "Yeah, but if Aites had anything to do with it, I won't come down." So Pat called me in and talked to me. I said, "Let's let him decide." I said, "Okay, I'll bring my limb down." I said, "I'd find you another vein of water." So I went down in the parking lot and I walked around, found a vein of water there. I told Pat, "Here's one here I measured. Its 57 feet deep." It's probably 100 feet from the other one. So he called then, Millat, the well driller down. And he said, "Okay, lets go out in the parking lot." They went out in the parking lot and they walked around a little while. Pat Cohen took him to this spot I had found. It was marked on the ground. And Pat's moving his foot around and Millat said, "Okay let's work around here some place." Pat Cohen put his foot right on the spot we had marked. He said, "Let's drill here." Millat says, "Okay, that sounds good." (chuckles) So he come down and drilled a nine inch hole. He went to 57 and 1/2 feet deep. Got all kinds of water. I guaranteed him 40 gallon a minute. He drilled it 57 and 1/2 feet and their flow was over 50 gallon. (chuckles) There using that today and I found that in a...oh boy...'73. I think it was in '73. And they are still pumping that and using all kinds of water. The bill went from $180 a month down to $40 a month. (chuckles)

Gaisford: That's good.

Aites: Yeah, I think they probably have that right in their record down there.

Gaisford: How long have you been blind?

Aites: I can't see daylight. Went blind July the 5th, 1973.

Gaisford: So, has your ability changed any since you were blinded?

Aites: No, no, not a bit. For a matter of fact, its a gift of God. I don't know any more about it now then when I could see. No, I've been blindfolded by a good many people. I'd walk around there and find them a spot. They'd say, "Can we blindfold you?" They'd put something over my head and I'd walk around and find the same spot. You know, you can't change the water.

Gaisford: You talk about veins of water. In studying geology and hydrology, the study of the earth and water in the ground, we typically say aquifers run in several layers and not in small, thin veins of water. They are very large pools or continuous areas that have water in them. How would you relate a vein to that kind of analysis?

Aites: Well, most of them, around here, may be the size of my finger, the vein of water. That's a lot of water. The biggest one I ever found was up in Henry's Bend and I'd say it was maybe a foot wide. I don't know how big around that was, I couldn't tell. I know it was, let's say like a creek on top of the ground around a foot wide. That's the widest one I ever found, but most of them are the size of a pencil or my thumb. As a matter of fact, did you ever see how they did it when they drill.

Gaisford: No. I know how they drill, but I haven't watched them.

Aites: No. I mean to see the flow of water actually flowing down there.

Gaisford: No.

Aites: If you are around where they are drilling a well, I don't care if its 90', 100', 50'. Sun shines and you get a mirror, put it in your hand. You hold that mirror up to the sun and you can see that vein of water running down there. That's (chuckles) that's hard to believe but it works. Yeah, I had one that one fellow. I can't even think of his name. He told me, and I could see at the time, and he got a mirror. He held it up there in the sun and you could see the water. The one I happened to see was about the size of my finger. Come right out into that hole and going right down the hole they drilled.

Gaisford: What is the deepest you have found water at?

Aites: Oh boy, I'd say over 200 feet. I haven't kept track. I know it was over 200'. I measured an oil well up here one time, 1300'. (Chuckles) I didn't see it, but the driller who owned it, he said, "You're exactly right. I had that on the books. That's 1300'." (pause) Found one. The guy told me to come out. He wanted water. Okay, I went out and found him water and he lived about 100...the house was about 100' off his driveway. I found him water and I told him, "Oh boy, your water is not quite six feet deep." "Oh no," he said, " I can't have water that...I've lived here all these years and carried water." I said, "I know if you dig down there about three feet you're going to get water." "No, no, I can't." And there was a backhoe up and I says, "Why don't you get that fella with that backhoe, come down here and find out." So, after I left, he went and seen that fella and they went down the same evening. And that backhoe went down there. He got down just about three feet and there was moisture. One more scoop and there was water, just flowing. Another one right up here, up the road here, people hauled water for years. Fifteen years they had lived there and they hauled water. I went up, he called me up and told me he can't get water. I said, "Let's look." And I found it. I took him right down in his basement. I found water. I said, "You got water right under your basement floor." I think it was nine feet. "Oh, no," he said. "Jess, I've been hauling water all the time I've lived here. I know there's not water here 'cause so-and-so didn't have water." "Okay," I said, "You asked me to come up, I told you." And they went down in the basement and they got that water. Nine feet. All them years they didn't have water, yet it was there. That's the reason I say its a gift from God. I can't put water where it isn't. I can tell them where its at if there is any. And when I go to places like that and they say, "Fifteen years I lived here and so-and-so couldn't get water." Its there. I can tell you where I moved, one fella was digging. Glenn Perry was digging a well in his front yard. He was down 35 feet. Gang of men digging it. They had me come out to find water and I found it in his back yard at 21'. "We can't have water, we're 3o some feet." "Well, you asked me to come out." They moved from the front of the house out back of the house. They dug it out there. Got water exactly at 21 feet. So, I know it works. Like I said, I never charge a nickel for it.

Gaisford: Sir, I thank you for your time. If there is anything else I can think of to ask you is it alright to give you a call?

Aites: Oh, yes. You can call me anytime.

Appendix C

Experiment Materials List

Item	Quantity	Measure
Adapter, 3/4" F x 1/2 S	2	Ea
Adapters, 3/4 M x 1/2 S	10	Ea
Brackets, Equipment Support	1	Pair
Cement, PVC, 4 oz	2	Ea
Cleaner, PVC, 8 oz	1	Ea
Couplings, 1/2", S-S	17	Ea
Elbow, 90, 1/2", S-S	11	Ea
Elbow, 45, 1/2", S-S	16	Ea
Pipe, Steel, 3/4" x 3"	2	Ea
Plywood, 3/4" x 24" x 30"	1	Ea
Power Cord, 12-3	10	Ft
Pump, Bell and Gossett Model SLC-30	1	Ea
Tape, Teflon	1	Roll
Tee, 1/2", S-S-S	8	Ea
Threaded Rod, 3/8" x 4"	2	Ea
Tubing, PVC, 1/2"	540	Feet
Valve, Ball, 1/2", S-S	5	Ea
Valve, Check, 3/4", F-F	5	Ea
Valve, Gate, 1/2", Brass	1	Ea

S - Smooth F - Female Thread M - Male Thread

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Vita

David Ira Gaisford was born in Pasadena, Texas in 1959. His father was an Air Force pilot allowing David to live in several communities during his childhood. He attended college at the University of Texas at Austin and graduated in 1983 with a bachelor of science degree in Architectural Engineering.

David entered active duty as an Air Force Civil Engineering officer in October 1983. He served at Holloman AFB, New Mexico, Howard AFB, Panama, Myrtle Beach AFB, South Carolina, and Wright-Patterson AFB, Ohio.

During Operation Desert Shield/Storm, David worked as the Chief of Engineering for the 354th Tactical Fighter Wing (Deployed) at King Fahd International Airport, Kingdom of Saudi Arabia. His efforts were paramount to creating an operational air base to house over 5000 troops and 100 aircraft. These efforts were the basis for him receiving the Bronze Star during that war.

In 1992, David was sent to the Air Force Institute of Technology (AFIT) to earn his master's degree. Air Force leadership, however, decided that it didn't need non-rated, experienced, reserve officers and choose to release him from active duty.

In January 1993, David started work as an Environmental Engineer for Robins AFB, Georgia. He immediately made plans to return to AFIT to finish the master's degree program he had started. He was selected to continue his education with the 94S Class and returned to Wright-Patterson AFB in January 1994.

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September 1994 Master's Thesis

EXPERIMENT IN WATER DOWSING

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AFIT/GEE/ENS/94S-01

Dowsing is a folklore process used to locate an unknown, such as the best location for a water well, by the use of a hand-held device. The process is commonly know as water witching, divining, dowsing or radiesthesia. The practice continues despite the lack of a proven scientific basis.

This research develops an experiment to test the claims of a dowser. Specific procedures are established and statistical theory is applied to determine if one man can identify which of five water lines has flowing water in it better than a chance operator could achieve. The statistical analysis uses Abraham Wald's sequential analysis procedures for establishing when to accept a hypothesis in a binomial situation. The dowser's performance proved to be better than chance. Further research is recommended.

Dowsing, Water Witching, Sequential Analysis, Binomial Experiment 88

Unclassified Unclassified Unclassified UL